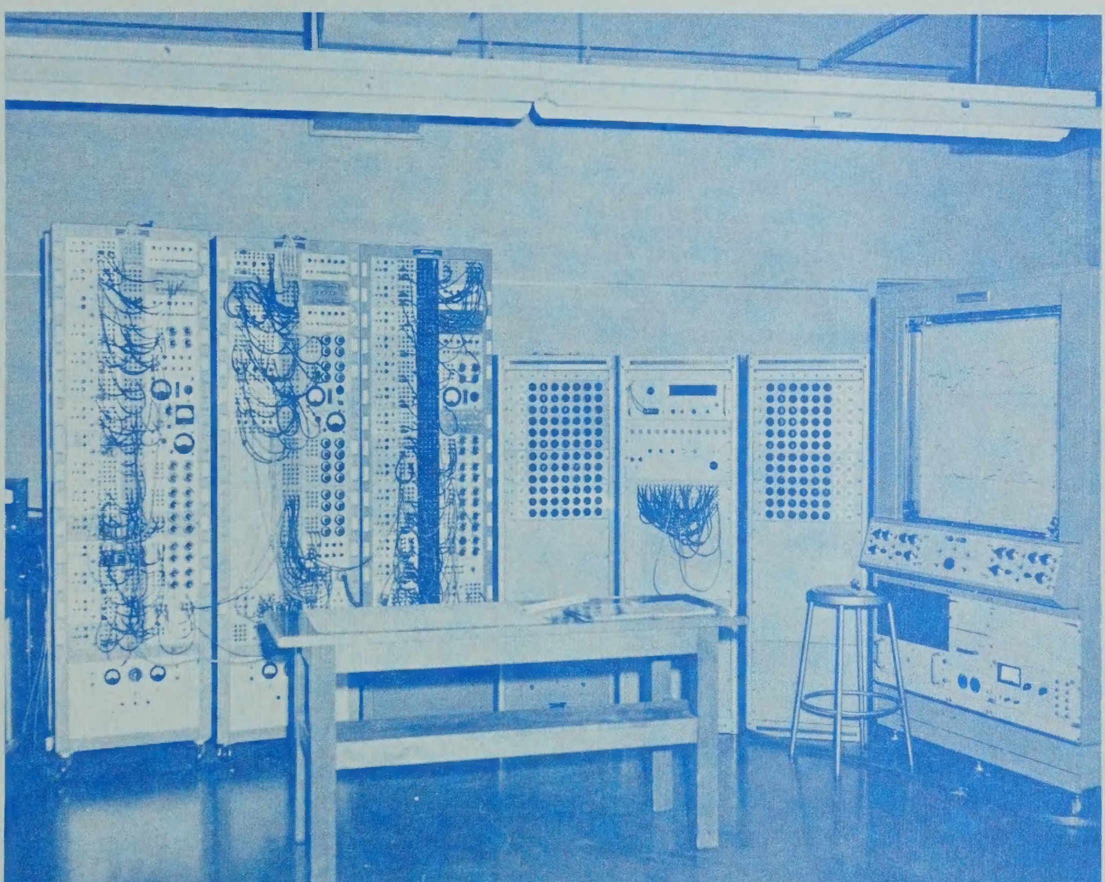
APPENDIX VIII

# ANALOG MODEL WATER BUDGET STUDIES
# SEVIER RIVER BASIN, UTAH



United States Department of Agriculture
Economic Research Service ● Forest Service ● Soil Conservation Service

MARCH 1970

APPENDIX VIII

ANALOG MODEL WATER BUDGET STUDIES

SEVIER RIVER BASIN, UTAH

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Salt Lake City, Utah

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# CHAPTER I

## INTRODUCTION

The purpose of the electronic analog model water budget study of the Sevier River Basin was to assist in determining the impacts of soil and water conservation projects on river flow as well as on hydrologic conditions within study areas. These effects were analyzed under various levels of water supply.

The river basin was subdivided into study areas as small as possible for this analysis but with divisions still occurring at established streamflow gaging stations. These gaging stations were necessary reference points required for calibrating the analog model. For programming convenience, each study area was divided into two segments: (1) the valley, made up of the irrigated rotation cropland and the wetland area, and (2) the tributary watershed, comprising the remainder of the area. Watersheds lacking sufficient hydrologic data and significant water use activity were not studied. Map 1 shows the Sevier River Basin study area and Map 2 locates the analog model study area.

A consecutive series of recent years were programmed, generally 1960 through 1963, in order to minimize the effect of inaccurate assumptions of antecedent hydrologic conditions. However, the study period varied from area to area depending on the data available. In areas where adequate specific year information was lacking, the data developed for the average annual water budgets were used. To obtain different levels of water supply for these areas, the average water supply was adjusted on a frequency basis to represent wet (20 percent chance) and dry (80 percent chance) conditions.

### BASIC DATA COMPILATION

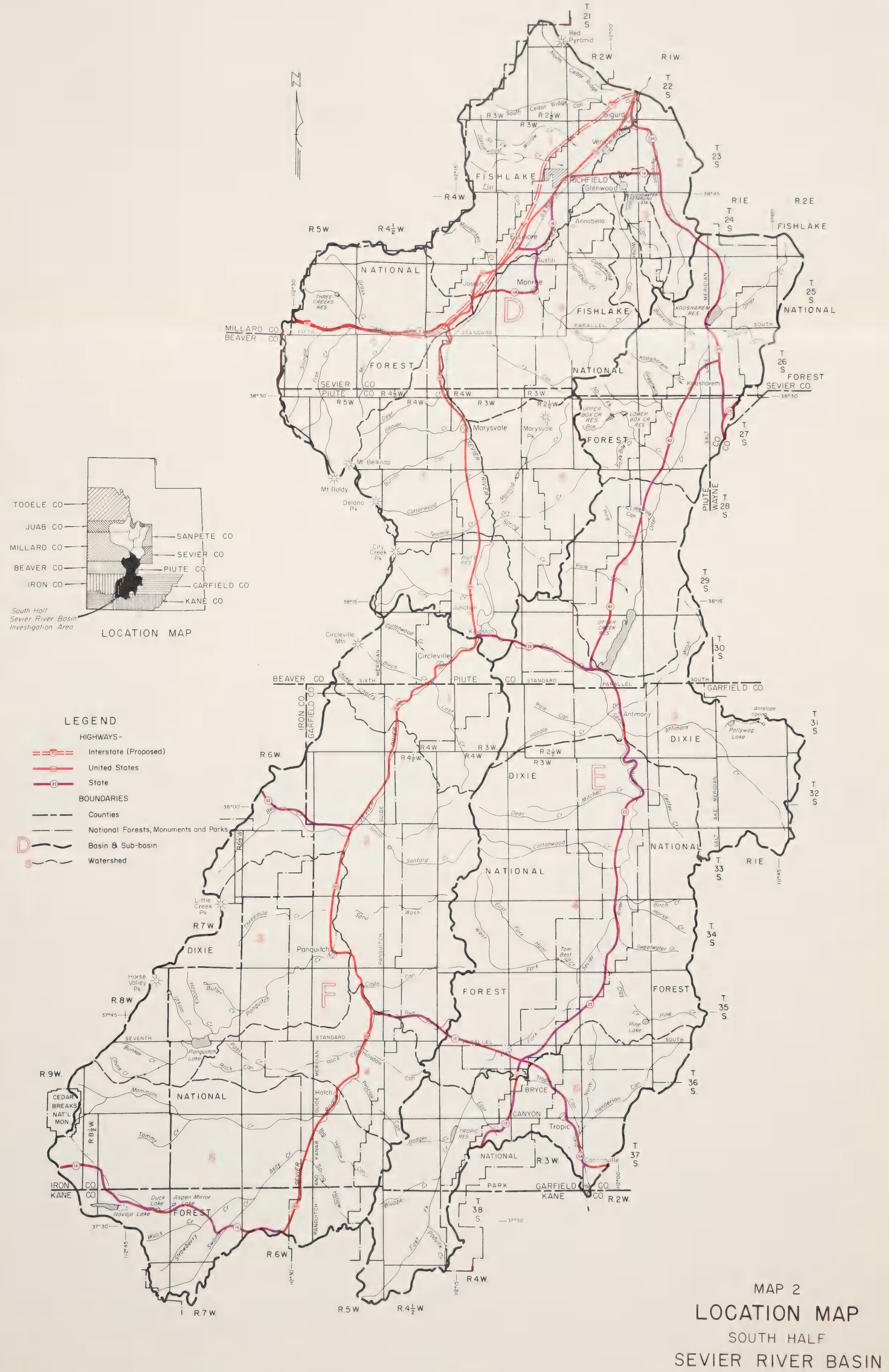
Monthly precipitation, in inches, was obtained from the U.S. Weather Bureau Climatological Data for the station(s) within each study area. These precipitation values, or the weighted average if there were more than one station, were adjusted as necessary to represent the average occurring over the valley segment of the study area. The average precipitation over the tributary watershed area was determined in a similar manner using records of snow courses and storage gages.


# MAP 2
## LOCATION MAP
NORTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE    USDA-SCS-PORTLAND, OREG. 1969

NORTH HALF M7-R-18935-N




MAP 2

# LOCATION MAP

SOUTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

SCALE IN MILES

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1969


MAP 2
MODEL AREA MAP
SEVIER RIVER BASIN
UTAH

NOVEMBER 1969

Mean monthly temperature, in $^{\circ}$ F, was obtained from the U.S. Weather Bureau Climatological Data and adjusted to represent the average over the valley area. In order to determine the mean temperature for the tributary watershed area, it was necessary to ascertain the mean elevation and use a lapse rate of -3.5$^{\circ}$ F per 1,000 foot raise in elevation to adjust the valley temperature.

Monthly water surface evaporation, in inches, for each year studied was determined using records of nearby U.S. Weather Bureau pan evaporation stations and adjusting them as necessary to represent the evaporation from water surfaces. The evaporation study described in Appendix I, Climate, was used to fill in months having no record, and to provide useable values in areas where no satisfactory record was available.

The monthly percent of daytime hours was obtained from the Smithsonian Meteorological Tables, 1951, for the average latitude of the area. These factors do not change from year to year.

The monthly vegetative growth stage coefficients ($k_c$) were determined as described in Appendix IV, Water Budget Analysis. For the non-growing season period of annual crops, a monthly coefficient of 0.25, corresponding to bare ground evaporation, was used. Equipment limitations required using a consolidated $k_c$ for the wet area which was obtained by weighting the individual coefficients. Growth stage coefficients for mountain vegetation were not developed. For this study, grass pasture was used as an approximate monthly $k_c$ for the tributary watershed area.

U.S. Geological Survey surface water records were used to compile the monthly river inflow and outflow, in acre-feet, for each area and year studied. Canal and groundwater flows bypassing the river gages were determined and added to the gaged flow to obtain the total inflow and outflow.

Monthly canal diversions from the river, in acre-feet, were compiled from the Sevier River Commissioners' reports. Water supplies from wells were estimated from irrigation company records, electrical energy consumed by pumping, or well yield as determined by U.S. Geological Survey test pumping or flow measurements. Canal and well diversion to root zone irrigation efficiencies for present conditions were used as developed for the average annual water budgets.

The total acreage of the modeled area was grouped into either tributary watershed area, rotation cropland area, or wet area. Each of these areas were further subdivided by vegetative type, water surfaces other than major reservoirs, and bare ground within the rotation cropland area and wetland area. Major reservoirs were investigated separately. The bare ground acreage was deducted from the study area on the assumption that there was an annual balance between precipitation and evaporation. In areas where there was considerable bare

ground over a shallow water table, the evaporation loss was computed and consolidated with the rest of the wetland area.

Determination of the root zone soil moisture storage capacity in acre-inches per acre for the rotation cropland area and the tributary watershed area was based on the water holding capabilities of the soils and rooting depths of the vegetative types. The water in root zone storage in the tributary watershed area at the beginning of a study period was considered as the excess of precipitation over consumptive use for the months immediately preceding where the mean monthly temperature exceeded 28° F. Rotation cropland root zone storage at the beginning of the study period was taken from the average annual water budgets and adjusted to conform to the relative wetness or dryness of the previous historical year.

Snow storage was considered only on the tributary watershed areas. Antecedent snow storage for the first year of the study period was taken as the total precipitation of the months immediately preceding where the mean monthly temperature was below 28° F.

## ANALOG MODEL PROGRAMMING TECHNIQUES

The physical appearance of the Sevier River Basin Analog Model is shown in Figures 1, 2 and 3. The captions to these figures briefly describe the components and their general function. For a more detailed description of the model, see the Utah State University Water Research Laboratory report RPWG 25-1 entitled, "The Development of an Electronic Analog Device for Hydrologic Investigations and Conservation Planning in the Sevier River Basin."

### Circuit Diagram Design

During the original development of the analog model, the methods of simulation and the circuitry were devised for such hydrologic factors as precipitation, runoff, snowmelt, consumptive use, soil moisture storage, and change in groundwater storage. Later programing for each study area required only the design of interconnections of the individual circuits to best represent the conditions in each area. A flow chart or circuit diagram was drawn using the generally accepted analog computer symbols and notations (Figure 4). In each area, it was also necessary to estimate the ratio of surface water to groundwater tributary runoff and that portion of the surface runoff actually diverted into the irrigation systems. The routing of the groundwater portion of the tributary runoff and the irrigation losses were determined using available information.

Experience with the first few models for Sub-basins E and F showed that the inadequate data for the water yielding area and the limited amount of analog equipment forced the computed tributary yield to conform

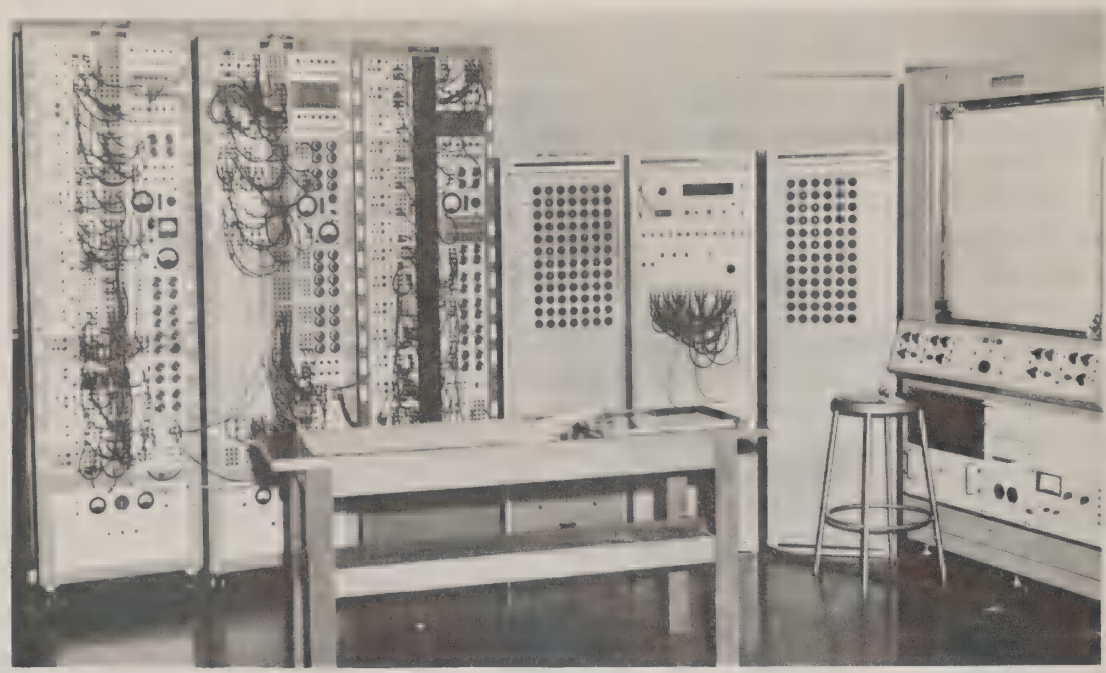


Figure 1 - Sevier River Basin Investigation Analog Model showing the amplifier racks (3), the main control panel, the input potentiometer panels, and the plotter. 8-1155-14

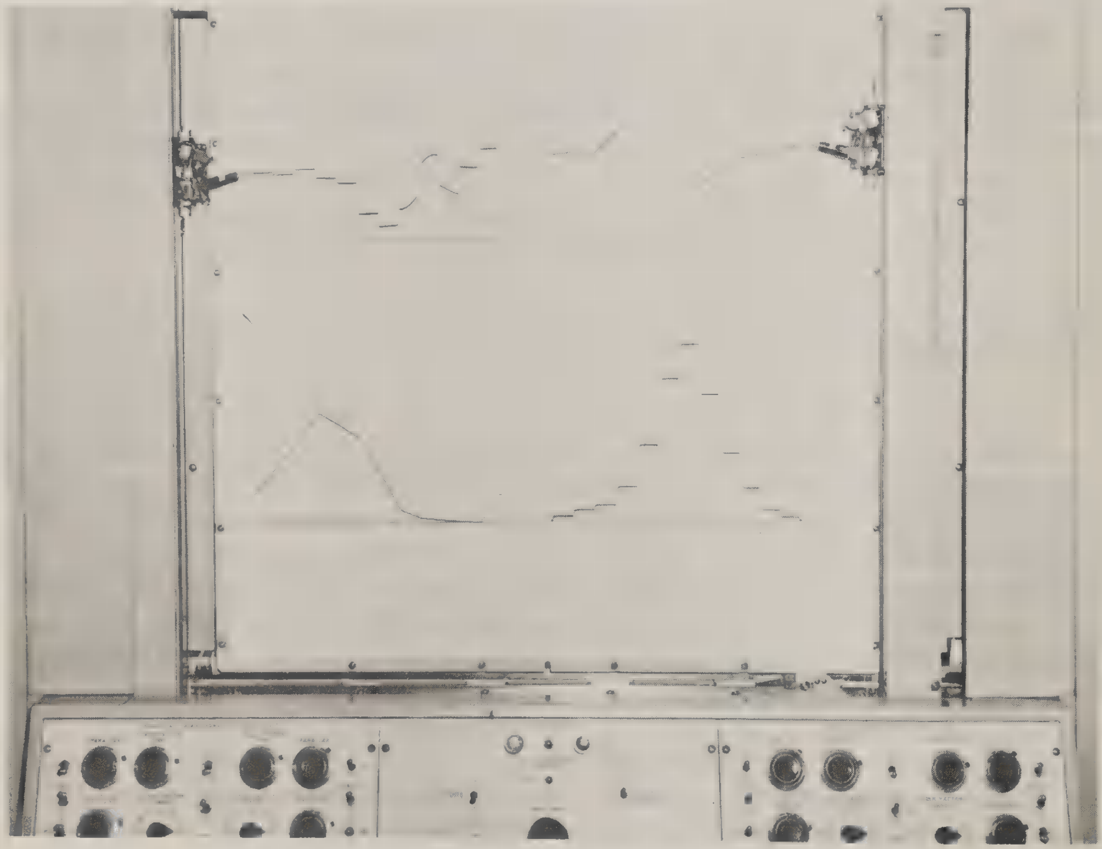


Figure 2 - The plotter used to record the output of the SRBI Analog Model. Items plotted are for Panguitch Valley for 1961; upper left is River Outflow, upper right is Cropland Soil Moisture Level, lower left is Contents of a Proposed Reservoir and lower right is Cropland Potential Consumptive Use. 8-1155-12

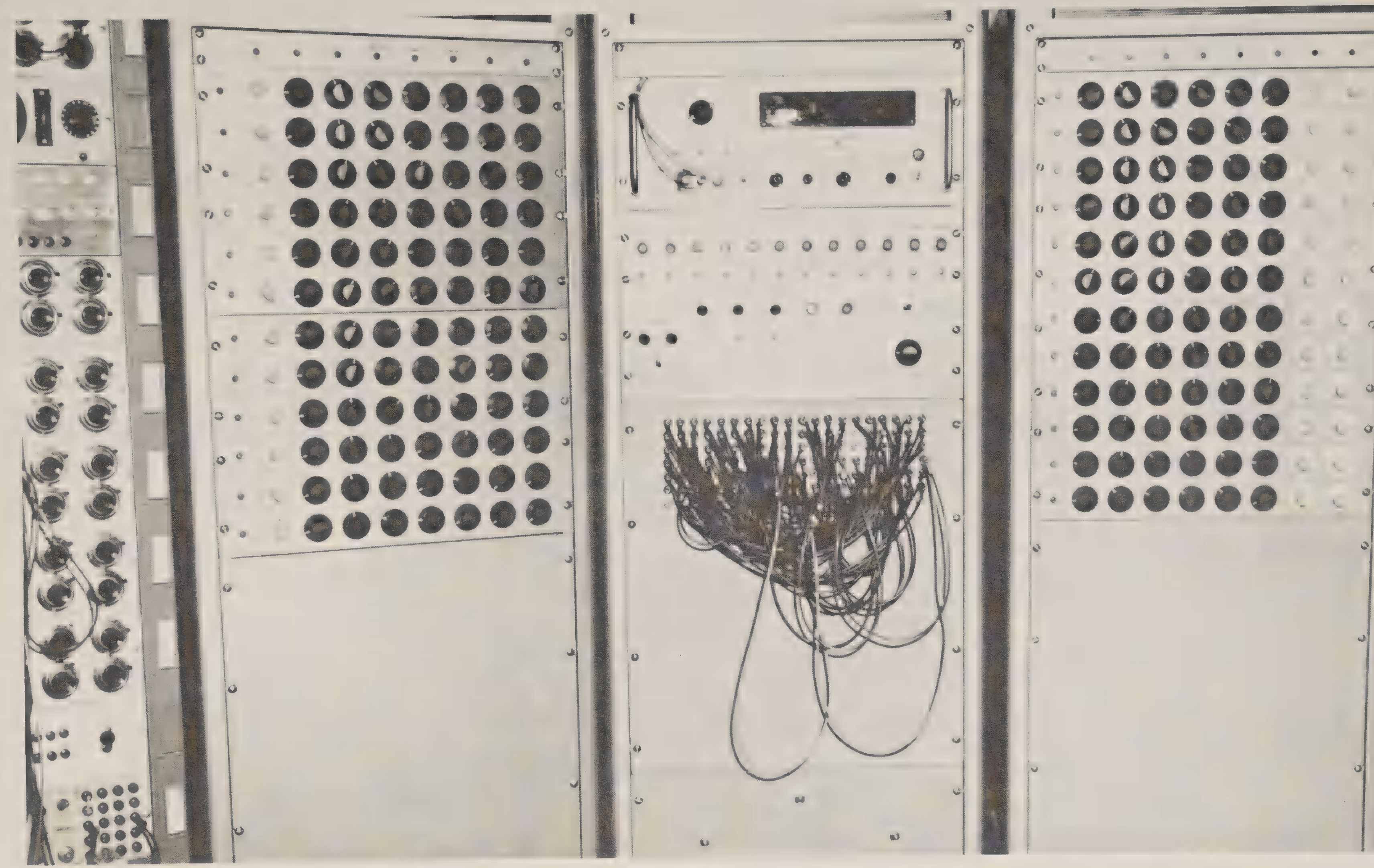


Figure 3 - SRBI Analog Model main control panel and digital voltmeter with the input potentiometer panels on each side.

8-1155-13

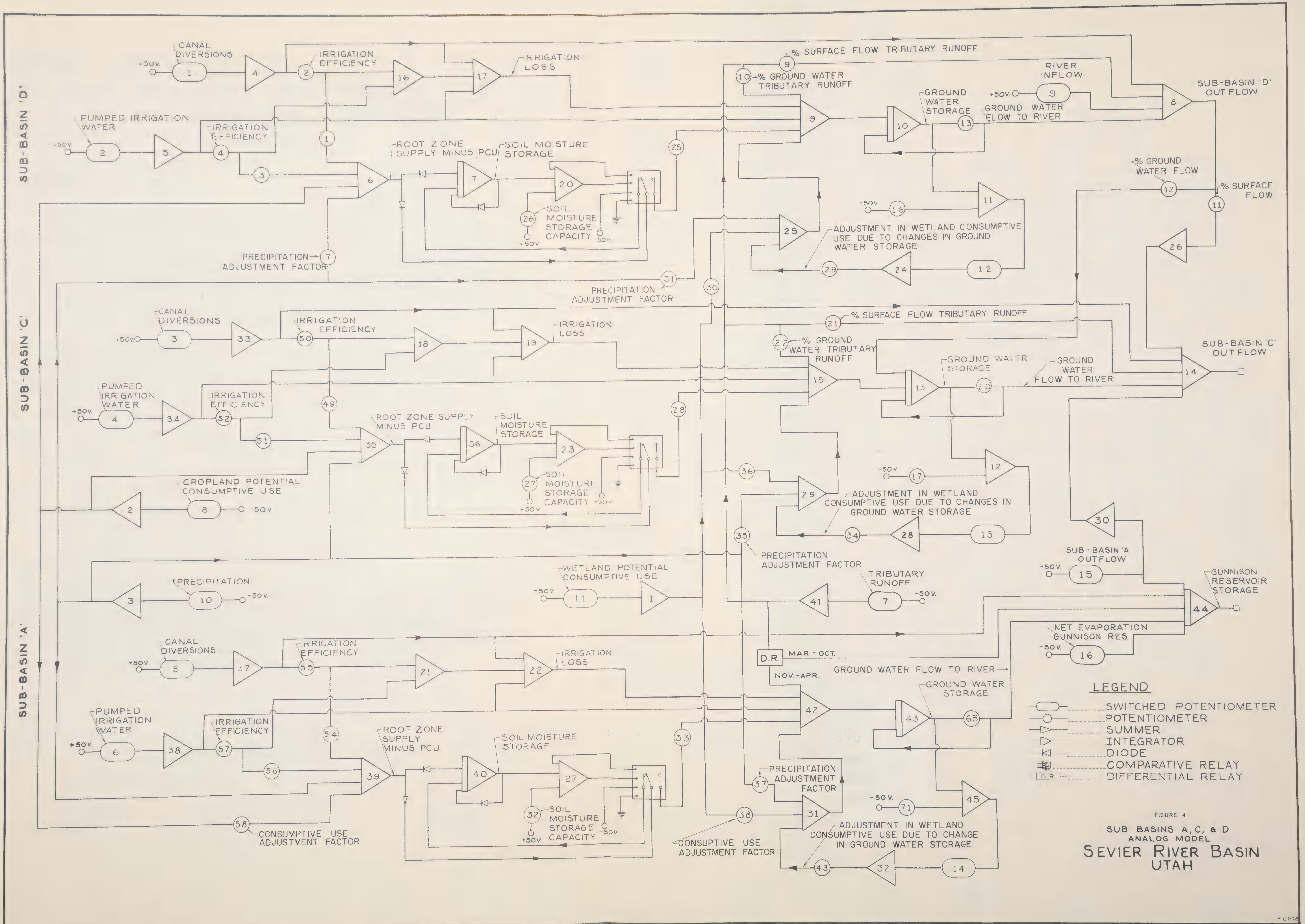



FIGURE 4

SUB BASINS A, C, & D
ANALOG MODEL
SEVIER RIVER BASIN
UTAH

with predetermined estimates of this value. Therefore, it was no better than the yield estimated from water yield maps. Thereafter, the yield map runoff data was used as an input item and the available analog equipment was used to model the cropland and wetland portions of the study areas. This was the case for the models of Sub-basins B, C, D and the combined model of Sub-basins A, C and D.

## Model Scaling

Two types of scaling were considered; time scaling and magnitude scaling. Time scaling relates machine time to real time. This was accomplished in the original development of the machine with one second of machine time representing one month of real time. Magnitude scaling relates voltage to the units of the actual data. As $\pm$ 50 volts was the maximum allowable, the voltage at all points within the model were kept within this range to prevent overloading of the amplifiers and resulting introduction of errors into the program.

The basic data was scaled so that the maximum monthly value of each variable was represented by a voltage as near to as possible, but not exceeding 50 volts, and still provide a convenient scale factor. (eq. 10 volts = 1 inch, 1 volt = 1000 ac. ft., etc.). The equation used in scaling the basic data was:

$$\bar{x} = \left(\frac{50 \text{ volts}}{|x_{max}|}\right) x$$

where: x is the value of an item of data,

$|x_{max}|$ is the absolute value of the maximum expected for this item,

and $\bar{x}$ is the voltage representing x in the model.

Another phase of magnitude scaling within the model was converting from one unit to another and one scale to another so that variables being summed were in compatible units and scales. The adjustment factor required to produce this compatibility was made up of an amplifier gain and a potentiometer setting, if needed. This adjustment factor was determined using the following series of equations:

$$x = \bar{x}$$

$$y = \bar{y}$$

$$\text{Adjustment factor} = \frac{\bar{y}}{\bar{x}} = BG$$

where x is the value of the variable before adjustment,

$\bar{x}$ is the voltage representing x,

y is the equivalent value of x in the new units,

$\bar{y}$ is the voltage representing y,

B is the potentiometer setting $(0 < B \leq 1)$

and, G is the gain of the amplifier and is equal to the ratio of the feedback resistance or capacitance to the input resistance.

## MODEL CALIBRATION

After the model was wired in accordance with the circuit diagram of the study area under consideration, the voltages representing each item of input data and initial conditions for the first year of the study period were set on the model by adjusting the appropriate potentiometers. In the actual calibration process, the measured outflow was first plotted as a standard of comparison. The outflow, as determined from the analog model, was then plotted and compared with the measured values on a monthly and annual basis. The differences between the two graphs were noted and the necessary adjustments of the estimated factors in the program were made so that the computed outflow agreed as closely as possible with the measured outflow. All adjustments were made using sound hydrologic principles so that the model became a better representation of the hydrology of the study area with each adjustment.

When one year was adjusted as best it could be, the next year was set up and adjusted. This process was continued until the entire series of years could be plotted with no further adjustment. The model was then considered calibrated even though an individual month's outflow may not agree exactly with the measured outflow. This disagreement was due to errors inherent in the basic data and equipment as well as the inability to exactly model the hydrology of a study area.

## PROJECT EFFECT EVALUATION

To determine and evaluate the effects of possible soil and water conservation projects, the input and initial condition data for the first year of the study period were again set up on the analog model. In order to provide a reference point, graphs were plotted showing the existing conditions of each item for which changes were to be measured. Generally these items were (1) monthly outflow, (2) annual outflow, (3) groundwater storage, (4) cropland soil moisture storage, and (5) root zone moisture supply minus consumptive use (Figure 2).

The program was then altered to reflect project measures or a change in level of water supply. The resulting effects were plotted and compared with the existing graphs. This process was repeated until all desired projects and levels of water supply for all years had been investigated. Year-end conditions for each project were set up as the beginning conditions of the next year so that project effects were carried over from one year to the next. From the graphs plotted, the effects within the study area and on the flow of the river could be easily identified and measured.

# CHAPTER II

## SUB-BASIN F ANALOG MODEL

### DESCRIPTION OF THE MODEL

Sub-basin F was evaluated using three separate models. The first included all of Watershed F-5, the second all of Watersheds F-2, 3 and 4, and the third all of Watershed F-1. The circuitry used for each of these models was essentially the same as originally developed by the Utah Water Research Laboratory. The effect of routing water through the groundwater basins was simulated through time-delay networks with the length of delay determined during calibration.

Two types of data were used to describe the area being modeled: (1) Values that do not change once the model has been calibrated, and (2) values that change monthly. The constant data are listed in Table 1 along with the potentiometer settings required for simulation. Inadequate information on some basic data had to be first estimated and then determined more accurately by trial and error during calibration of the model. These are indicated by an asterisk. The variable data is shown in Table 2 for each of the three models along with their actual values and voltage settings required for simulation.

For these models, a series of years was programmed in order to minimize the effect of estimating initial conditions. Years having different levels of water supply also give some insight into the effects of a variable water supply. The specific years selected were determined mainly on the basis of available data as follows:

| | |
|---|---|
| Watershed F-1 | 1960-1963 |
| Watersheds F-2, 3 and 4 | 1961-1963 |
| Watershed F-5 | 1959-1962 |

### CONDITIONS INVESTIGATED

A series of irrigation efficiencies was programmed for each of the years data input. These were selected over a range so that generalized relationships could be developed to analyze the effects of any specific project which would increase the irrigation efficiency. The irrigation efficiencies discussed here are over-all efficiencies measured from the point of diversion to the crop root zone. The efficiencies programmed for each model are listed on the following page:

| Watershed F-1 | Watersheds F-2, 3 and 4 | Watershed F-5 |
|---|---|---|
| 30% | 25% | 30% (present) |
| 35% (present) | 30% (present) | 50% |
| 50% | 50% | |

A proposed reservoir above Hatchtown was included in the Watershed F-2, 3 and 4 model to evaluate some of the effects it would have on this area. A reservoir with a maximum surface area of 510 acres and a total capacity of 13,650 acre-feet was programmed to store water during the months of January, February, March and December. During the other months the reservoir inflow was routed with no change in volume or timing. Utilization of the stored water was determined by adding increments of irrigated areas.

A project was programmed for Watershed F-1 which included conversion of 3,000 acres of wetland to cropland. This acreage would be irrigated by pumping from the groundwater basin. Project irrigation efficiencies selected were 35 percent for canal water and 40 percent for pumped water.

TABLE 1a.--Hydrologic factors of constant value for Watershed F-1 model

| Description of factor | Potentiometer number | Actual value | Potentiometer setting[a] |
|---|---|---|---|
| Tributary watershed area (acres) | | 84,700 | |
| Cropland area (acres) | | 4,580 | |
| Wetland area (acres) | | 3,430 | |
| Soil moisture-holding capacity (inches) | | | |
| Tributary watershed[b] | 5 | 8 | 20.0 |
| Cropland | 31 | 10.25 | 25.62 |
| Canal irrigation efficiency (percent) | 33 | 35.0 | 17.5 |
| Pumped water irrigation efficiency (percent) | 34 | 40 | 20.0 |
| Percent of cropland in grain | 53 | 18 | 9.0 |
| Percent of cropland in potatoes | 54 | 8 | 4.0 |
| Percent of cropland in corn | 55 | 4 | 2.0 |
| Percent of cropland in alfalfa | 56 | 70 | 35.0 |
| Percent of irrigation loss as surface outflow[b] | 64 | 25 | 12.5 |
| Temperature difference between valley and mean mountain elevation ($^{o}$ F) | 4 | 5 | 5.0 |
| Ratio of mountain to valley precipitation | | | |
| May-September[b] | 23 | 1.72 | 21.5 |
| October-April[b] | 24 | 2.50 | 31.25 |
| Runoff threshold (inches)[b] | 10 | 5 | 0.20[c] |
| Percent of deep percolation tributary runoff[c] | 21 | 70 | 35.0 |
| Percent of quick return flow tributary runoff[b] | 22 | 30 | 15.0 |
| Time delay-deep percolation routing[b] | | 5 months | |
| Time delay-quick return flow routing[b] | | 1 month | |
| Time delay-valley groundwater routing[b] | | 4 months | |

[a]Arm voltage when high side of potentiometer was connected at 50 volts.
[b]Values determined by trial and error during calibration.
[c]Potentiometer dial setting.

TABLE 1b.--Hydrologic factors of constant value for Watersheds F-2, 3 and 4 model

| Description of factor | Potentiometer number | Actual value | Potentiometer setting[a] |
|---|---|---|---|
| Tributary watershed area (acres) | | 341,050 | |
| Cropland area (acres) | | 12,000 | |
| Wetland area (acres) | | 3,270 | |
| Water surface area (acres) | | 380 | |
| Soil moisture-holding capacity (inches) | | | |
| Tributary watershed[b] | 25 | 6 | 15.0 |
| Cropland | 21 | 8.0 | 20.0 |
| Canal irrigation efficiency (percent) | 29 | 30 | 15.0 |
| Percent of cropland in grain | 53 | 16 | 8.0 |
| Percent of cropland in alfalfa | 54 | 64 | 32.0 |
| Percent of cropland in irrigated pasture | 55 | 20 | 10.0 |
| Temperature difference between valley and mean mountain elevation ($^{o}$ F) | 1 | 3.5 | 3.5 |
| Runoff threshold (inches)[b] | 21 | 4.7 | 0.225[c] |
| Percent of deep percolation-tributary runoff[b] | 17 | 50 | 25.0 |
| Percent of quick return flow-tributary runoff[b] | 18 | 50 | 25.0 |
| Time delay-deep percolation routing[b] | | 5 months | |
| Time delay-quick return flow routing[b] | | 1 month | |
| Time delay-valley ground-water routing[b] | | 5 months | |

[a]Arm voltage when high side of potentiometer was connected at 50 volts.

[b]Values determined by trial and error during calibration.

[c]Potentiometer dial setting.

TABLE 1c.--Hydrologic factors of constant value for Watershed F-5 model

| Description of factor | Potentiometer number | Actual value | Potentiometer setting[a] |
|---|---|---|---|
| Tributary watershed area (acres) | | 205,730 | |
| Cropland area (acres) | | 2,260 | |
| Wetland area (acres) | | 460 | |
| Soil moisture-holding capacity (inches) | | | |
| Tributary watershed[b] | 5 | 6.5 | 32.5 |
| Cropland | 29 | 8.1 | 8.1 |
| Canal irrigation efficiency | 28 | 30 | 15.0 |
| Percent of cropland in grain | 53 | 10 | 5.0 |
| Percent of cropland in alfalfa | 54 | 39 | 19.5 |
| Percent of cropland in irrigated pasture | 55 | 51 | 25.5 |
| Temperature difference between valley and mean mountain elevation (° F) | 1 | 4.4 | 4.4 |
| Runoff threshold (inches)[b] | 10 | 4 | 0.30[c] |
| Percent of deep percolation-tributary runoff[b] | 18 | 50 | 25.0 |
| Percent of quick return flow-tributary runoff[b] | 20 | 50 | 25.0 |
| Percent of surface tributary runoff[b] | 33 | 98 | 49.0 |
| Percent of groundwater tributary runoff[b] | 34 | 2 | 1.0 |
| Time delay-deep percolation routing[b] | | 5 months | |
| Time delay-valley groundwater routing[b] | | 5 months | |
| Time delay-quick return flow routing[b] | | 1 month | |

[a]Arm voltage when high side of potentiometer was connected to 50 volts.

[b]Values determined by trial and error during calibration.

[c]Potentiometer dial setting.

TABLE 2a.-- Monthly type input data for Watershed F-1 Model, 1960

| Month | Precipitation | | Mountain day-time hours | | Valley day-time hours | | Temperature | | Canal diversions | | Pumped water | | River inflow | | River outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.31 | 3.1 | 6.86 | 3.43 | 6.86 | 20.8 | 25.6 | 12.8 | --- | --- | --- | --- | 5,550 | 11.10 | 7,270 | 14.54 |
| 2 | 0.63 | 6.3 | 6.79 | 3.40 | 6.79 | 20.6 | 27.2 | 13.6 | --- | --- | --- | --- | 5,440 | 10.90 | 7,030 | 14.06 |
| 3 | 0.44 | 4.4 | 8.34 | 4.17 | 8.34 | 25.3 | 39.7 | 19.8 | --- | --- | --- | --- | 7,160 | 14.30 | 8,180 | 16.36 |
| 4 | 0.20 | 2.0 | 8.90 | 4.45 | 8.90 | 27.0 | 45.5 | 22.8 | 4,070 | 20.35 | --- | --- | 4,250 | 8.50 | 1,550 | 3.10 |
| 5 | 0.25 | 2.5 | 9.92 | 4.96 | 9.92 | 30.0 | 53.3 | 26.6 | 3,710 | 18.55 | 150 | 0.75 | 4,020 | 8.04 | 1,690 | 3.38 |
| 6 | 0.00 | 0.0 | 9.96 | 4.98 | 9.96 | 30.2 | 64.0 | 32.0 | 1,420 | 7.10 | 210 | 1.05 | 1,480 | 2.96 | 1,270 | 2.54 |
| 7 | 0.10 | 1.0 | 10.11 | 5.06 | 10.11 | 30.7 | 69.8 | 34.9 | 1,280 | 6.40 | 220 | 1.10 | 1,410 | 2.82 | 1,120 | 2.24 |
| 8 | 0.04 | 0.4 | 9.48 | 4.74 | 9.48 | 28.7 | 67.1 | 33.6 | 1,400 | 7.00 | 180 | 0.90 | 1,530 | 3.06 | 1,070 | 2.14 |
| 9 | 0.70 | 7.0 | 8.38 | 4.19 | 8.38 | 25.4 | 62.9 | 31.4 | 1,920 | 9.60 | 180 | 0.90 | 2,190 | 4.38 | 1,180 | 2.36 |
| 10 | 1.64 | 16.4 | 7.80 | 3.90 | 7.80 | 23.6 | 48.3 | 24.2 | 2,800 | 14.00 | 180 | 0.90 | 3,210 | 6.42 | 1,260 | 2.52 |
| 11 | 1.50 | 15.0 | 6.80 | 3.40 | 6.80 | 20.6 | 36.7 | 18.4 | 1,415 | 7.08 | --- | --- | 4,710 | 9.42 | 4,520 | 9.04 |
| 12 | 0.00 | 0.0 | 6.65 | 3.32 | 6.65 | 20.1 | 27.8 | 13.9 | --- | --- | --- | --- | 5,310 | 10.62 | 6,260 | 12.52 |

| Month | Grain $k_c$ | | Potatoes $k_c$ | | Corn $k_c$ | | Alfalfa $k_c$ | | Wet area $k_c$ | | Mountain $k_c$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.25 | 6.25 | 0.25 | 6.25 | 0.25 | 6.25 | 0.68 | 17.00 | 0.70 | 10.50 | 0.48 | 12.00 | | | | |
| 2 | 0.25 | 6.25 | 0.25 | 6.25 | 0.25 | 6.25 | 0.79 | 19.75 | 0.70 | 10.50 | 0.57 | 14.25 | | | | |
| 3 | 0.25 | 6.25 | 0.25 | 6.25 | 0.25 | 6.25 | 0.89 | 22.25 | 0.75 | 11.25 | 0.73 | 18.25 | | | | |
| 4 | 0.26 | 6.50 | 0.25 | 6.25 | 0.25 | 6.25 | 0.99 | 24.75 | 0.81 | 12.20 | 0.85 | 21.25 | | | | |
| 5 | 0.50 | 12.50 | 0.25 | 6.25 | 0.26 | 6.50 | 1.08 | 27.00 | 0.89 | 13.40 | 0.90 | 22.50 | | | | |
| 6 | 1.54 | 38.50 | 0.38 | 9.50 | 0.60 | 15.00 | 1.11 | 27.75 | 1.02 | 15.30 | 0.92 | 23.00 | | | | |
| 7 | 1.13 | 28.25 | 0.90 | 22.50 | 1.29 | 32.25 | 1.10 | 27.50 | 1.18 | 17.70 | 0.92 | 23.00 | | | | |
| 8 | 0.25 | 6.25 | 1.31 | 32.75 | 1.08 | 27.00 | 1.08 | 27.00 | 1.28 | 19.20 | 0.91 | 22.75 | | | | |
| 9 | 0.25 | 6.25 | 1.32 | 33.00 | 0.42 | 10.50 | 1.01 | 25.25 | 1.29 | 19.35 | 0.87 | 21.75 | | | | |
| 10 | 0.25 | 6.25 | 0.25 | 6.25 | 0.25 | 6.25 | 0.92 | 23.00 | 1.19 | 17.85 | 0.80 | 20.00 | | | | |
| 11 | 0.25 | 6.25 | 0.25 | 6.25 | 0.25 | 6.25 | 0.81 | 20.25 | 1.04 | 15.60 | 0.67 | 16.75 | | | | |
| 12 | 0.25 | 6.25 | 0.25 | 6.25 | 0.25 | 6.25 | 0.69 | 17.25 | 0.86 | 12.90 | 0.55 | 13.75 | | | | |

TABLE 2a continued

1961

| Month | Precipitation | | Temperature | | Canal diversions | | Pumped water | | River inflow | | River outflow | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.49 | 4.9 | 28.0 | 14.0 | --- | --- | --- | --- | 5,170 | 10.34 | 6,090 | 12.18 | | | | |
| 2 | 0.24 | 2.4 | 31.4 | 15.7 | --- | --- | --- | --- | 5,270 | 10.54 | 5,910 | 11.82 | | | | |
| 3 | 1.80 | 18.0 | 33.0 | 16.5 | --- | --- | --- | --- | 6,450 | 12.90 | 7,380 | 14.76 | | | | |
| 4 | 0.37 | 3.7 | 45.0 | 22.5 | 5,040 | 25.2 | --- | --- | 5,760 | 11.52 | 2,710 | 5.42 | | | | |
| 5 | 0.44 | 4.4 | 54.4 | 27.2 | 4,290 | 21.45 | 178 | 0.89 | 4,390 | 8.78 | 1,520 | 3.04 | | | | |
| 6 | 0.00 | 0.0 | 64.6 | 32.3 | 1,540 | 7.70 | 209 | 1.05 | 1,640 | 3.28 | 1,320 | 2.64 | | | | |
| 7 | 0.63 | 6.3 | 70.9 | 35.5 | 1,340 | 6.70 | 199 | 1.00 | 1,520 | 3.04 | 1,280 | 2.56 | | | | |
| 8 | 1.83 | 18.3 | 67.4 | 33.7 | 2,890 | 14.45 | 206 | 1.03 | 3,370 | 6.74 | 1,880 | 3.76 | | | | |
| 9 | 1.55 | 15.5 | 54.0 | 27.0 | 3,580 | 17.90 | --- | --- | 6,340 | 12.68 | 6,150 | 12.30 | | | | |
| 10 | 0.11 | 1.1 | 46.0 | 23.0 | 3,090 | 15.45 | --- | --- | 2,920 | 5.84 | 2,590 | 5.18 | | | | |
| 11 | 0.45 | 4.5 | 32.3 | 16.2 | 1,197 | 5.98 | --- | --- | 4,520 | 9.04 | 5,300 | 10.60 | | | | |
| 12 | 0.65 | 6.5 | 26.3 | 13.2 | --- | --- | --- | --- | 5,680 | 11.36 | 6,410 | 12.82 | | | | |

1962

| Month | Precipitation | | Temperature | | Canal diversions | | Pumped water | | River inflow | | River outflow | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.75 | 7.4 | 22.2 | 11.10 | --- | --- | --- | --- | 5,060 | 10.12 | 6,080 | 12.16 | | | | |
| 2 | 0.86 | 8.6 | 31.7 | 15.85 | --- | --- | --- | --- | 8,690 | 17.38 | 9,610 | 19.22 | | | | |
| 3 | 0.70 | 7.0 | 34.6 | 17.30 | --- | --- | --- | --- | 11,030 | 22.06 | 12,180 | 24.36 | | | | |
| 4 | 1.25 | 12.5 | 50.7 | 25.35 | 5,240 | 26.20 | --- | --- | 18,370 | 36.74 | 14,530 | 29.06 | | | | |
| 5 | 0.72 | 7.2 | 53.3 | 26.65 | 7,410 | 37.05 | --- | --- | 18,290 | 36.58 | 13,570 | 27.14 | | | | |
| 6 | 0.54 | 5.4 | 62.5 | 31.25 | 5,360 | 26.80 | --- | --- | 7,270 | 14.54 | 3,230 | 6.46 | | | | |
| 7 | 0.30 | 3.0 | 69.2 | 34.60 | 2,890 | 14.45 | --- | --- | 3,230 | 6.46 | 1,690 | 3.38 | | | | |
| 8 | 0.12 | 1.2 | 68.1 | 34.05 | 2,500 | 12.50 | 31 | 0.155 | 2,640 | 5.28 | 1,460 | 2.92 | | | | |
| 9 | 0.85 | 8.5 | 61.3 | 30.65 | 3,390 | 16.95 | 188 | 0.94 | 3,780 | 7.56 | 1,440 | 2.88 | | | | |
| 10 | 0.37 | 3.7 | 51.7 | 25.85 | 4,510 | 22.55 | 166 | 0.83 | 5,270 | 10.54 | 3,330 | 6.66 | | | | |
| 11 | 0.12 | 1.2 | 40.3 | 20.15 | 2,369 | 11.85 | --- | --- | 6,330 | 12.66 | 6,020 | 12.04 | | | | |
| 12 | 0.23 | 2.3 | 29.8 | 14.90 | --- | --- | --- | --- | 6,210 | 12.42 | 6,110 | 12.22 | | | | |

TABLE 2a continued

1963

| Month | Precipitation | | Temperature | | Canal diversions | | Pumped water | | River inflow | | River outflow | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.34 | 3.4 | 24.0 | 12.0 | --- | --- | --- | --- | 4,650 | 9.30 | 4,970 | 9.94 | | | | |
| 2 | 0.82 | 8.2 | 37.1 | 18.6 | --- | --- | --- | --- | 7,100 | 14.20 | 7,415 | 14.83 | | | | |
| 3 | 0.32 | 3.2 | 36.3 | 18.2 | --- | --- | --- | --- | 6,120 | 12.24 | 6,270 | 12.54 | | | | |
| 4 | 0.74 | 7.4 | 41.2 | 20.6 | 3,037 | 15.18 | --- | --- | 3,580 | 7.16 | 1,800 | 3.60 | | | | |
| 5 | 0.11 | 1.1 | 58.2 | 29.1 | 4,504 | 22.52 | 189 | 0.95 | 5,350 | 10.70 | 2,070 | 4.14 | | | | |
| 6 | 0.74 | 7.4 | 60.0 | 30.0 | 1,677 | 8.38 | 188 | 0.94 | 1,820 | 3.64 | 1,526 | 3.05 | | | | |
| 7 | 0.46 | 4.6 | 70.8 | 35.4 | 1,423 | 7.12 | 204 | 1.02 | 1,600 | 3.20 | 1,015 | 2.03 | | | | |
| 8 | 3.43 | 34.3 | 67.6 | 33.8 | 2,404 | 12.02 | 163 | 0.82 | 2,710 | 5.42 | 1,117 | 2.23 | | | | |
| 9 | 1.31 | 13.1 | 61.8 | 30.9 | 3,234 | 16.17 | 101 | 0.50 | 3,780 | 7.56 | 1,640 | 3.28 | | | | |
| 10 | 0.49 | 4.9 | 54.2 | 27.1 | 2,446 | 12.23 | --- | --- | 2,650 | 5.30 | 1,484 | 2.97 | | | | |
| 11 | 0.62 | 6.2 | 38.5 | 19.2 | 1,562 | 7.81 | --- | --- | 4,430 | 8.86 | 3,190 | 6.38 | | | | |
| 12 | 0.15 | 1.5 | 25.9 | 12.9 | --- | --- | --- | --- | 6,210 | 12.42 | 6,645 | 13.29 | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |

TABLE 2b.--Monthly type input data for Watershed F-2, 3, & 4 **Model**, 1961

| Month | Valley precipitation | | Mountain day-time hours | | Valley day-time hours | | Temperature | | Mountain precipitation[a] | | Canal diversions | | Use from groundwater | | Panguitch Creek | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.30 | 3.0 | 6.87 | 3.44 | 6.87 | 20.82 | 24.8 | 12.40 | 1.05 | 10.5 | 268 | 1.07 | 9 | 0.09 | 230 | 2.30 |
| 2 | 0.02 | 0.2 | 6.79 | 3.40 | 6.79 | 20.57 | 32.0 | 16.00 | 0.10 | 1.0 | 537 | 2.15 | 16 | 0.16 | 280 | 2.80 |
| 3 | 1.97 | 19.7 | 8.34 | 4.17 | 8.34 | 25.27 | 32.6 | 16.30 | 2.45 | 24.5 | 608 | 2.44 | 42 | 0.42 | 330 | 3.30 |
| 4 | 0.80 | 8.0 | 8.90 | 4.45 | 8.90 | 26.97 | 42.4 | 21.20 | 0.90 | 9.0 | 2,540 | 10.16 | 105 | 1.05 | 380 | 3.80 |
| 5 | 0.20 | 2.0 | 9.92 | 4.96 | 9.92 | 30.06 | 50.7 | 25.35 | 0.60 | 6.0 | 7,347 | 29.40 | 184 | 1.84 | 545 | 5.45 |
| 6 | 0.11 | 1.1 | 9.95 | 4.98 | 9.95 | 30.15 | 61.8 | 30.90 | 0.10 | 1.0 | 7,757 | 31.00 | 269 | 2.69 | 2,420 | 24.20 |
| 7 | 1.74 | 17.4 | 10.10 | 5.05 | 10.10 | 30.60 | 66.5 | 33.25 | 1.45 | 14.5 | 6,486 | 26.00 | 351 | 3.51 | 1,780 | 17.80 |
| 8 | 4.13 | 41.3 | 9.47 | 4.74 | 9.47 | 28.69 | 63.6 | 31.80 | 4.85 | 48.5 | 6,958 | 27.80 | 309 | 3.09 | 1,390 | 13.90 |
| 9 | 2.16 | 21.6 | 8.38 | 4.19 | 8.38 | 25.39 | 52.5 | 26.25 | 2.59 | 25.9 | 3,903 | 15.60 | 200 | 2.00 | 280 | 2.80 |
| 10 | 0.14 | 1.4 | 7.80 | 3.90 | 7.80 | 23.63 | 44.1 | 22.05 | 0.40 | 4.0 | 5,318 | 21.30 | 101 | 1.01 | 198 | 1.98 |
| 11 | 0.17 | 1.7 | 6.82 | 3.41 | 6.82 | 20.66 | 31.4 | 15.70 | 0.25 | 2.5 | 2,072 | 8.29 | 31 | 0.31 | 213 | 2.13 |
| 12 | 0.57 | 5.7 | 6.66 | 3.33 | 6.66 | 20.18 | 23.9 | 11.95 | 1.00 | 10.0 | 374 | 1.50 | 13 | 0.13 | 223 | 2.23 |

| Month | Grain $k_c$ | | Alfalfa $k_c$ | | Irrigated pasture $k_c$ | | Wet area $k_c$ | | Mountain $k_c$ | | Watershed evaporation | | River inflow | | River outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.25 | 6.25 | 0.68 | 17.00 | 0.48 | 12.00 | 0.84 | 12.60 | 0.49 | 12.25 | 0.59 | 2.95 | 2,530 | 5.06 | 5,170 | 10.34 |
| 2 | 0.25 | 6.25 | 0.79 | 19.75 | 0.57 | 14.25 | 0.82 | 12.30 | 0.58 | 14.50 | 0.95 | 4.75 | 2,430 | 4.86 | 5,270 | 10.54 |
| 3 | 0.25 | 6.25 | 0.89 | 22.25 | 0.73 | 18.25 | 0.89 | 13.35 | 0.75 | 18.75 | 1.99 | 10.00 | 2,880 | 5.76 | 6,450 | 12.90 |
| 4 | 0.25 | 6.25 | 0.99 | 24.75 | 0.85 | 21.25 | 0.96 | 14.40 | 0.87 | 21.75 | 3.21 | 16.10 | 3,870 | 7.74 | 5,760 | 11.52 |
| 5 | 0.27 | 6.75 | 1.08 | 27.00 | 0.90 | 22.50 | 1.05 | 15.75 | 0.92 | 23.00 | 6.24 | 31.20 | 7,990 | 15.98 | 4,390 | 8.78 |
| 6 | 1.12 | 28.00 | 1.11 | 27.75 | 0.92 | 23.00 | 1.16 | 17.40 | 0.94 | 23.50 | 7.93 | 39.60 | 3,660 | 7.32 | 1,640 | 3.28 |
| 7 | 1.55 | 38.75 | 1.10 | 27.50 | 0.92 | 23.00 | 1.30 | 19.50 | 0.94 | 23.50 | 7.31 | 36.60 | 2,720 | 5.44 | 1,520 | 3.04 |
| 8 | 0.44 | 11.00 | 1.08 | 27.00 | 0.91 | 22.75 | 1.38 | 20.70 | 0.93 | 23.25 | 3.36 | 16.80 | 3,470 | 6.94 | 3,370 | 6.74 |
| 9 | 0.25 | 6.25 | 1.01 | 25.25 | 0.87 | 21.75 | 1.39 | 20.85 | 0.89 | 22.25 | 4.72 | 23.60 | 4,580 | 9.16 | 6,340 | 12.68 |
| 10 | 0.25 | 6.25 | 0.92 | 23.00 | 0.80 | 20.00 | 1.32 | 19.80 | 0.82 | 20.50 | 3.29 | 16.50 | 3,340 | 6.68 | 2,920 | 5.84 |
| 11 | 0.25 | 6.25 | 0.81 | 20.25 | 0.67 | 16.75 | 1.19 | 17.85 | 0.69 | 17.25 | 1.52 | 7.60 | 2,660 | 5.32 | 4,520 | 9.04 |
| 12 | 0.25 | 6.25 | 0.69 | 17.25 | 0.55 | 13.75 | 1.02 | 15.30 | 0.56 | 14.00 | 0.71 | 3.55 | 2,730 | 5.46 | 5,680 | 11.36 |

[a] Mountain precipitation is 100 percent of Panguitch Lake Storage gage.

TABLE 2b continued

1962

| Month | Valley precipitation | | Temperature | | Mountain precipitation[a] | | Canal diversions | | Panguitch Creek | | Watershed evaporation | | River inflow | | River outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.43 | 4.3 | 23.9 | 11.95 | 0.77 | 7.7 | 287 | 1.15 | 178 | 1.78 | 0.59 | 2.95 | 2,730 | 5.46 | 5,060 | 10.12 |
| 2 | 1.46 | 14.6 | 30.7 | 15.35 | 2.87 | 28.7 | 399 | 1.60 | 342 | 3.42 | 0.95 | 4.75 | 5,840 | 11.68 | 8,690 | 17.38 |
| 3 | 0.81 | 8.1 | 29.2 | 14.60 | 1.50 | 15.0 | 1,417 | 5.66 | 1,120 | 11.20 | 1.99 | 9.95 | 6,540 | 13.08 | 11,030 | 22.06 |
| 4 | 0.40 | 4.0 | 46.7 | 23.35 | 0.30 | 3.0 | 5,456 | 21.80 | 3,070 | 30.70 | 3.21 | 16.10 | 14,840 | 29.68 | 18,370 | 36.74 |
| 5 | 0.92 | 9.2 | 49.5 | 24.75 | 1.10 | 11.0 | 10,130 | 40.60 | 1,430 | 14.30 | 5.44 | 27.20 | 23,170 | 46.34 | 18,290 | 36.58 |
| 6 | 1.11 | 11.1 | 57.9 | 28.95 | 0.80 | 8.0 | 10,800 | 43.20 | 3,440 | 34.40 | 6.67 | 33.40 | 10,020 | 20.04 | 7,270 | 14.54 |
| 7 | 0.89 | 8.9 | 63.3 | 31.65 | 0.85 | 8.5 | 10,356 | 41.40 | 3,110 | 31.10 | 7.55 | 37.80 | 5,810 | 11.62 | 3,230 | 6.46 |
| 8 | 0.27 | 2.7 | 62.9 | 31.45 | 0.15 | 1.5 | 10,120 | 40.50 | 3,370 | 33.70 | 7.16 | 35.80 | 4,130 | 8.26 | 2,640 | 5.28 |
| 9 | 1.95 | 19.5 | 57.6 | 28.80 | 2.20 | 22.0 | 7,244 | 29.00 | 1,430 | 14.30 | 5.96 | 29.80 | 3,770 | 7.54 | 3,780 | 7.56 |
| 10 | 0.72 | 7.2 | 47.2 | 23.60 | 1.10 | 11.0 | 5,122 | 20.50 | 330 | 3.30 | 3.55 | 17.80 | 3,560 | 7.12 | 5,270 | 10.54 |
| 11 | 0.31 | 3.1 | 39.0 | 19.50 | 0.40 | 4.0 | 2,752 | 11.00 | 247 | 2.47 | 1.52 | 7.60 | 3,580 | 7.16 | 6,330 | 12.66 |
| 12 | 0.30 | 3.0 | 24.7 | 12.35 | 0.65 | 6.5 | 1,307 | 5.24 | 299 | 2.99 | 0.71 | 3.55 | 3,440 | 6.88 | 6,210 | 12.42 |

1963

| Month | Valley precipitation | | Temperature | | Mountain precipitation[a] | | Canal diversions | | Panguitch Creek | | Watershed evaporation | | River inflow | | River outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.35 | 3.5 | 19.4 | 9.70 | 0.50 | 5.0 | 301 | 1.20 | 247 | 2.47 | 0.59 | 2.95 | 3,090 | 6.18 | 4,650 | 9.30 |
| 2 | 0.72 | 7.2 | 33.5 | 16.75 | 1.20 | 12.0 | 419 | 1.75 | 311 | 3.11 | 0.95 | 4.75 | 3,150 | 6.30 | 7,100 | 14.20 |
| 3 | 0.57 | 5.7 | 31.9 | 15.95 | 1.55 | 15.5 | 1,536 | 6.14 | 386 | 3.86 | 1.99 | 9.95 | 3,180 | 6.36 | 6,120 | 12.24 |
| 4 | 0.61 | 6.1 | 41.0 | 20.50 | 1.70 | 17.0 | 4,492 | 17.95 | 350 | 3.50 | 3.21 | 16.10 | 3,370 | 6.74 | 3,580 | 7.16 |
| 5 | T | 0.0 | 53.7 | 26.85 | 0.00 | 0.0 | 9,230 | 36.90 | 1,430 | 14.30 | 6.58 | 32.90 | 9,330 | 18.66 | 5,350 | 10.70 |
| 6 | 0.76 | 7.6 | 57.3 | 28.65 | 0.88 | 8.8 | 8,568 | 34.30 | 2,840 | 28.40 | 7.20 | 36.00 | 3,530 | 7.06 | 1,820 | 3.64 |
| 7 | 0.72 | 7.2 | 66.2 | 33.10 | 0.59 | 5.9 | 6,205 | 24.80 | 1,910 | 19.10 | 8.58 | 42.90 | 2,680 | 5.36 | 1,600 | 3.20 |
| 8 | 3.39 | 33.9 | 63.8 | 31.90 | 5.17 | 50.0 | 6,051 | 24.20 | 1,420 | 14.20 | 5.94 | 29.70 | 3,130 | 6.26 | 2,710 | 5.42 |
| 9 | 0.34 | 3.4 | 59.1 | 29.55 | 1.16 | 11.6 | 5,460 | 21.80 | 865 | 8.65 | 5.16 | 25.80 | 2,980 | 5.96 | 3,780 | 7.56 |
| 10 | 0.02 | 0.2 | 50.7 | 25.35 | 0.60 | 6.0 | 4,743 | 18.95 | 326 | 3.26 | 3.55 | 17.80 | 2,540 | 5.08 | 2,650 | 5.30 |
| 11 | 0.40 | 4.0 | 36.8 | 18.40 | 1.05 | 10.5 | 2,987 | 11.95 | 210 | 2.10 | 1.52 | 7.60 | 2,650 | 5.30 | 4,430 | 8.86 |
| 12 | T | 0.0 | 26.4 | 13.20 | 0.09 | 0.9 | 441 | 1.76 | 207 | 2.07 | 0.71 | 3.55 | 2,770 | 5.54 | 6,210 | 12.42 |

[a] Mountain precipitation is 100 percent of Panguitch Lake Storage gage.

TABLE 2c.--Monthly type input data for Watershed F-5 Model, 1959

| Month | Valley precipitation | | Mountain daytime hours | | Valley daytime hours | | Temperature | | Mountain precipitation | | Loss to Virgin River | | Canal diversions | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.07 | 0.7 | 6.90 | 3.45 | 6.90 | 20.91 | 25.7 | 12.85 | 0.79 | 3.95 | 1,170 | 11.7 | 0 | 0 | | |
| 2 | 1.00 | 10.0 | 6.81 | 3.40 | 6.81 | 20.60 | 24.3 | 12.15 | 5.04 | 25.20 | 1,210 | 12.1 | 0 | 0 | | |
| 3 | 0.09 | 0.9 | 8.34 | 4.17 | 8.34 | 25.27 | 35.3 | 17.65 | 0.52 | 2.60 | 1,220 | 12.2 | 0 | 0 | | |
| 4 | 0.17 | 1.7 | 8.89 | 4.44 | 8.89 | 26.91 | 44.0 | 22.00 | 0.61 | 3.05 | 1,250 | 12.5 | 860 | 8.6 | | |
| 5 | 0.48 | 4.8 | 9.89 | 4.94 | 9.89 | 29.94 | 51.2 | 25.60 | 0.90 | 4.50 | 1,300 | 13.0 | 1,800 | 18.0 | | |
| 6 | 0.18 | 1.8 | 9.92 | 4.96 | 9.92 | 30.06 | 60.3 | 30.15 | 0.19 | 0.95 | 1,410 | 14.1 | 1,780 | 17.8 | | |
| 7 | 1.69 | 16.9 | 10.07 | 5.03 | 10.07 | 30.48 | 68.6 | 34.30 | 1.57 | 7.85 | 1,290 | 12.9 | 1,180 | 11.8 | | |
| 8 | 3.38 | 33.8 | 9.46 | 4.73 | 9.46 | 28.66 | 61.8 | 30.90 | 2.95 | 14.75 | 1,210 | 12.1 | 850 | 8.5 | | |
| 9 | 1.24 | 12.4 | 8.38 | 4.19 | 8.38 | 25.39 | 53.7 | 26.85 | 1.05 | 5.25 | 1,130 | 11.3 | 1,220 | 12.2 | | |
| 10 | 0.60 | 6.0 | 7.81 | 3.90 | 7.81 | 23.63 | 50.0 | 25.00 | 1.13 | 5.65 | 1,130 | 11.3 | 1,250 | 12.5 | | |
| 11 | 0.11 | 1.1 | 6.85 | 3.42 | 6.85 | 20.72 | 36.5 | 18.25 | 0.60 | 3.00 | 1,130 | 11.3 | 210 | 2.1 | | |
| 12 | 1.30 | 13.0 | 6.69 | 3.34 | 6.69 | 20.24 | 26.6 | 13.30 | 3.77 | 18.85 | 1,170 | 11.7 | 140 | 1.4 | | |

| Month | Grain $k_c$ | | Alfalfa $k_c$ | | Irrigated pasture $k_c$ | | Wet area $k_c$ | | Mountain $k_c$ | | Use from groundwater | | Outflow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.25 | 6.25 | 0.68 | 17.00 | 0.48 | 12.00 | 0.66 | 9.90 | 0.50 | 12.50 | 10 | 1.0 | 3,800 | 7.60 | | |
| 2 | 0.25 | 6.25 | 0.79 | 19.75 | 0.57 | 14.25 | 0.70 | 10.50 | 0.60 | 15.00 | 10 | 1.0 | 3,330 | 6.66 | | |
| 3 | 0.25 | 6.25 | 0.89 | 22.25 | 0.73 | 18.25 | 0.81 | 12.15 | 0.76 | 19.00 | 20 | 2.0 | 4,330 | 8.66 | | |
| 4 | 0.25 | 6.25 | 0.99 | 24.75 | 0.85 | 21.25 | 0.91 | 13.65 | 0.89 | 22.25 | 60 | 6.0 | 3,830 | 7.66 | | |
| 5 | 0.27 | 6.75 | 1.08 | 27.00 | 0.90 | 22.50 | 0.99 | 14.85 | 0.94 | 23.50 | 100 | 10.0 | 4,180 | 8.36 | | |
| 6 | 1.01 | 25.25 | 1.11 | 27.75 | 0.92 | 23.00 | 1.14 | 17.10 | 0.96 | 24.00 | 150 | 15.0 | 3,010 | 6.02 | | |
| 7 | 1.59 | 39.75 | 1.10 | 27.50 | 0.92 | 23.00 | 1.26 | 18.90 | 0.96 | 24.00 | 190 | 19.0 | 2,800 | 5.60 | | |
| 8 | 0.66 | 16.50 | 1.08 | 27.00 | 0.91 | 22.75 | 1.36 | 20.40 | 0.95 | 23.75 | 170 | 17.0 | 3,270 | 6.54 | | |
| 9 | 0.25 | 6.25 | 1.01 | 25.25 | 0.87 | 21.75 | 1.36 | 20.40 | 0.91 | 22.75 | 110 | 11.0 | 2,440 | 4.88 | | |
| 10 | 0.25 | 6.25 | 0.92 | 23.30 | 0.80 | 20.00 | 1.25 | 18.75 | 0.84 | 21.00 | 50 | 5.0 | 2,370 | 4.74 | | |
| 11 | 0.25 | 6.25 | 0.81 | 20.25 | 0.67 | 16.75 | 1.04 | 15.60 | 0.70 | 17.50 | 20 | 2.0 | 2,680 | 5.36 | | |
| 12 | 0.25 | 6.25 | 0.69 | 17.25 | 0.55 | 13.75 | 0.81 | 12.15 | 0.57 | 14.25 | 10 | 1.0 | 2,650 | 5.30 | | |

TABLE 2c continued

1960

| Month | Precipitation | | Temperature | | Mountain precipitation | | Canal diversions | | Outflow | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.38 | 3.8 | 19.5 | 9.75 | 1.71 | 8.55 | 0 | 0 | 2,300 | 4.60 | | | | | | |
| 2 | 0.53 | 5.3 | 22.1 | 11.05 | 2.31 | 11.55 | 0 | 0 | 2,520 | 5.04 | | | | | | |
| 3 | T | 0 | 37.6 | 18.80 | 1.57 | 7.85 | 0 | 0 | 3,540 | 7.08 | | | | | | |
| 4 | 0.51 | 5.1 | 42.9 | 21.45 | 1.82 | 9.10 | 790 | 7.9 | 4,240 | 8.48 | | | | | | |
| 5 | 0.19 | 1.9 | 50.3 | 25.15 | 0.63 | 3.15 | 1,690 | 16.9 | 6,820 | 13.64 | | | | | | |
| 6 | 0.81 | 8.1 | 61.5 | 30.75 | 0.52 | 2.60 | 1,650 | 16.5 | 3,650 | 7.30 | | | | | | |
| 7 | 0.85 | 8.5 | 65.6 | 32.80 | 0.88 | 4.40 | 1,080 | 10.8 | 2,680 | 5.36 | | | | | | |
| 8 | 0.54 | 5.4 | 64.4 | 32.20 | 0.60 | 3.00 | 1,000 | 10.0 | 2,250 | 4.50 | | | | | | |
| 9 | 1.16 | 11.6 | 59.9 | 29.95 | 1.82 | 9.10 | 1,300 | 13.0 | 2,080 | 4.16 | | | | | | |
| 10 | 1.72 | 17.2 | 47.0 | 23.50 | 2.64 | 13.20 | 540 | 5.4 | 2,490 | 4.98 | | | | | | |
| 11 | 0.94 | 9.4 | 36.6 | 18.30 | 2.67 | 13.35 | 80 | 0.8 | 2,690 | 5.38 | | | | | | |
| 12 | 0.40 | 4.0 | 25.2 | 12.60 | 1.26 | 6.30 | 0 | 0 | 2,660 | 5.32 | | | | | | |

1961

| Month | Precipitation | | Temperature | | Mountain precipitation | | Canal diversions | | Outflow | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.42 | 4.2 | 24.3 | 12.15 | 1.38 | 6.90 | 0 | 0 | 2,530 | 5.06 | | | | | | |
| 2 | 0.04 | 0.4 | 31.0 | 15.50 | 0.16 | 0.80 | 0 | 0 | 2,430 | 4.86 | | | | | | |
| 3 | 1.24 | 12.4 | 31.3 | 15.65 | 4.55 | 22.75 | 50 | 0.5 | 2,880 | 5.76 | | | | | | |
| 4 | 0.71 | 7.1 | 47.0 | 23.50 | 1.43 | 7.15 | 850 | 8.5 | 3,870 | 7.74 | | | | | | |
| 5 | 0.51 | 5.1 | 49.6 | 24.80 | 1.33 | 6.65 | 2,190 | 21.90 | 7,990 | 15.98 | | | | | | |
| 6 | 0.01 | 0.1 | 60.6 | 30.30 | 0.03 | 0.15 | 1,705 | 17.05 | 3,660 | 7.32 | | | | | | |
| 7 | 0.98 | 9.8 | 65.5 | 32.75 | 1.22 | 6.10 | 1,400 | 14.00 | 2,720 | 5.44 | | | | | | |
| 8 | 5.23 | 52.3 | 62.3 | 31.15 | 4.90 | 24.50 | 1,120 | 11.20 | 3,470 | 6.94 | | | | | | |
| 9 | 3.39 | 33.9 | 51.9 | 25.95 | 2.95 | 14.75 | 290 | 2.90 | 4,580 | 9.16 | | | | | | |
| 10 | 0.18 | 1.8 | 43.3 | 21.65 | 0.88 | 4.40 | 180 | 1.80 | 3,340 | 6.68 | | | | | | |
| 11 | 0.25 | 2.5 | 31.0 | 15.50 | 1.23 | 6.15 | 180 | 1.80 | 2,660 | 5.32 | | | | | | |
| 12 | 1.00 | 10.0 | 22.9 | 11.45 | 2.13 | 10.65 | 0 | 0 | 2,730 | 5.46 | | | | | | |

TABLE 2c continued

1962

| Month | Precipitation | | Temperature | | Mountain precipitation | | Canal diversions | | Outflow | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.41 | 4.1 | 23.9 | 11.95 | 2.42 | 12.10 | 0 | 0 | 2,730 | 5.46 | | | | | | |
| 2 | 1.71 | 17.1 | 30.3 | 15.15 | 5.50 | 27.50 | 0 | 0 | 5,840 | 11.68 | | | | | | |
| 3 | 0.80 | 8.0 | 37.0 | 18.50 | 3.29 | 16.45 | 0 | 0 | 6,540 | 13.08 | | | | | | |
| 4 | 0.12 | 1.2 | 46.0 | 23.00 | 0.40 | 2.00 | 140 | 1.4 | 14,840 | 29.68 | | | | | | |
| 5 | 0.45 | 4.5 | 48.8 | 24.40 | 1.43 | 7.15 | 2,190 | 21.9 | 23,170 | 46.34 | | | | | | |
| 6 | 0.24 | 2.4 | 57.0 | 28.50 | 0.87 | 4.35 | 2,260 | 22.6 | 10,020 | 20.04 | | | | | | |
| 7 | 0.63 | 6.3 | 62.2 | 31.10 | 0.80 | 4.00 | 1,710 | 17.1 | 5,810 | 11.62 | | | | | | |
| 8 | 0.00 | 0.0 | 61.9 | 30.95 | 0.10 | 0.50 | 1,430 | 14.3 | 4,130 | 8.26 | | | | | | |
| 9 | 1.57 | 15.7 | 56.8 | 28.40 | 2.57 | 12.85 | 1,430 | 14.3 | 3,770 | 7.54 | | | | | | |
| 10 | 0.80 | 8.0 | 46.6 | 23.30 | 1.23 | 6.15 | 960 | 9.6 | 3,560 | 7.12 | | | | | | |
| 11 | 0.16 | 1.6 | 38.5 | 19.25 | 0.67 | 3.35 | 480 | 4.8 | 3,580 | 7.16 | | | | | | |
| 12 | 0.38 | 3.8 | 24.0 | 12.00 | 0.92 | 4.60 | 0 | 0 | 3,440 | 6.88 | | | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |

## SUMMARY OF RESULTS

Tables 3, 4 and 5 show the on-site effects of increasing irrigation efficiencies. Figure 5 is a plot of the data in Table 5. The variation in the slope of the curves for different years is due to precipitation variations from year to year. A curve of average slope drawn through the deficit point, as determined in the average annual water budgets, produces a generalized curve relating cropland root-zone deficit to irrigation efficiency. These were used to estimate the on-site effect of increases in the over-all irrigation efficiency.

Table 6 shows the water releases from Hatchtown Reservoir to irrigate an increased acreage of 3,000 acres in 1961, 6,000 acres in 1962, and 3,000 acres in 1963 in Panguitch Valley. The values were set to prevent any excessive draw-down of either the reservoir or cropland soil moisture. In each of these cases, the canal diversions were increased the same amount as the storage releases.

Table 7 shows the volume of water for the Watershed F-1 pumping and wetland conversion project. The amount of water pumped was that necessary to provide the present 4,580 acres of irrigated cropland, plus 3,000 additional acres of wetland converted to irrigated cropland with a full supply without excessive soil moisture draw-down.

TABLE 3.--Cropland root zone deficit or surplus computed in analog model

| Watershed | Efficiency[a] | 1960 | 1961 | 1962 | 1963 |
|---|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| F-1 | 30 | -4,550 | -350 | +800 | 0 |
| | 35 | -4,050 | +200 | +2,300 | +550 |
| | 50 | -1,800 | +3,300 | +8,300 | +3,350 |
| F-2, 3 and 4 | 25 | ------ | 0 | +500 | 0 |
| | 30 | ------ | +200 | +3,350 | +2,400 |
| | 50 | ------ | +8,100 | +18,300 | +8,100 |
| F-5 | 30 | +300 | +500 | +500 | ------ |
| | 50 | +1,150 | +2,100 | +2,150 | ------ |

[a]Overall efficiency from diversion to root zone.

TABLE 4.--Change in cropland soil moisture storage

| Watershed | Efficiency[a] | 1960 | 1961 | 1962 | 1963 |
|---|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| F-1 | 30 | +550 | +50 | +600 | -1,450 |
| | 35 | +750 | +650 | +850 | -950 |
| | 50 | +1,350 | +1,550 | 0 | 0 |
| F-2, 3 and 4 | 25 | ------ | -600 | +700 | -4,300 |
| | 30 | ------ | +1,400 | +750 | -4,000 |
| | 50 | ------ | +2,000 | 0 | 0 |
| F-5 | 30 | -400 | +400 | 0 | ------ |
| | 50 | 0 | 0 | 0 | ------ |

[a]Overall efficiency from diversion to root zone.

TABLE 5.--Actual deficit - Root zone supply minus potential consumptive use

| Watershed | Efficiency[a] | 1960 | 1961 | 1962 | 1964 |
|---|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| F-1 | 30 | -4,000 | -300 | +1,400 | -1,450 |
| | 35 | -3,300 | +850 | +3,150 | -400 |
| | 50 | -450 | +4,850 | +8,300 | +3,350 |
| F-2, 3 and 4 | 25 | ------ | -600 | +1,200 | -4,300 |
| | 30 | ------ | +1,600 | +4,100 | -1,600 |
| | 50 | ------ | +10,100 | +18,300 | +8,100 |
| F-5 | 30 | -100 | +900 | +500 | ------ |
| | 50 | +1,150 | +2,100 | +2,150 | ------ |

[a]Overall efficiency from diversion to root zone.

Note: This table is a combination of Tables 6 and 7. Negative values are deficits; positive values are surpluses.

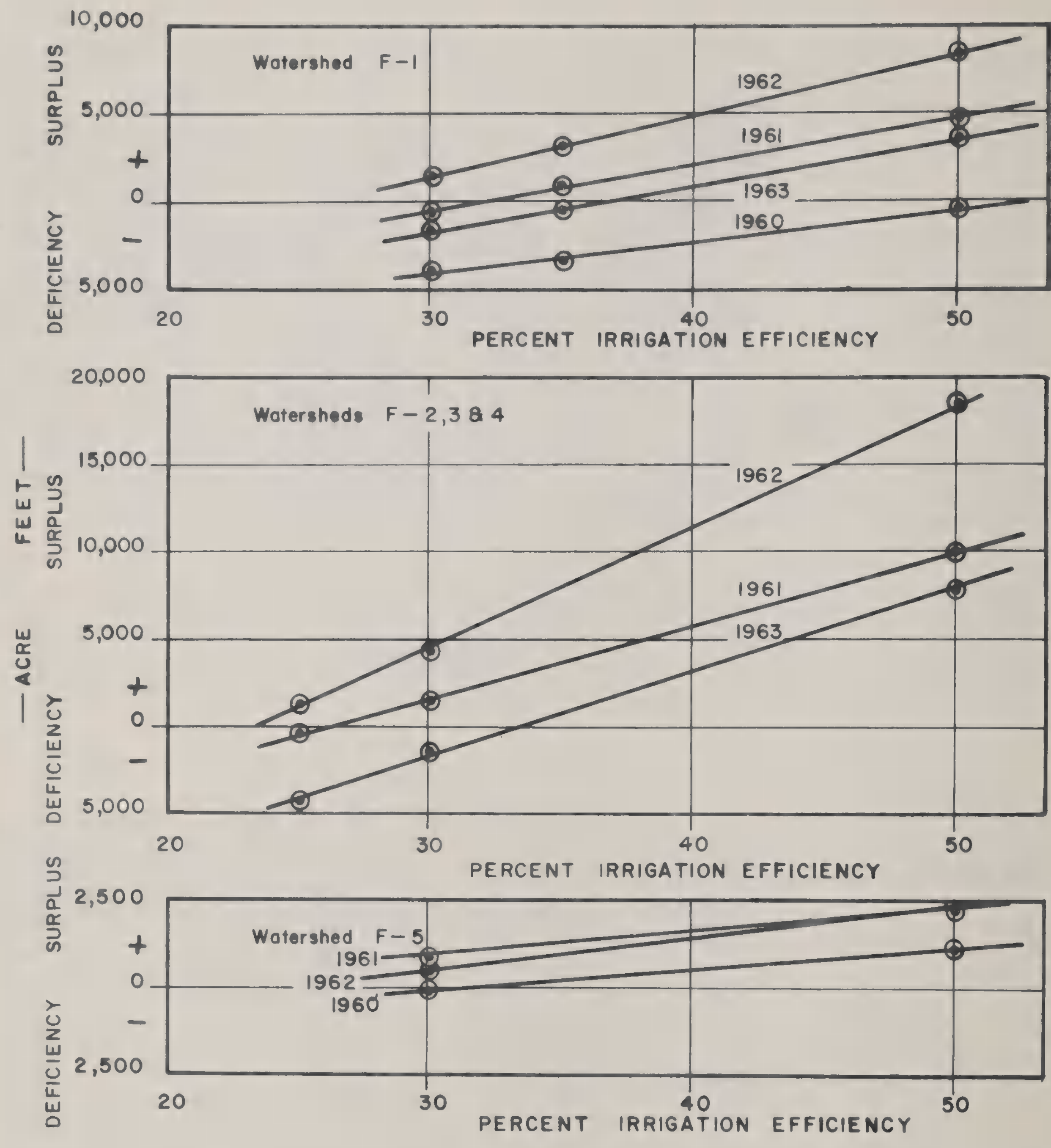



Figure 5

Root Zone Deficit — Surplus vs. Efficiency

Sub — basin F Analog Models

Sevier River Basin

Utah

TABLE 6.--Project reservoir releases from Hatchtown Reservoir

| Year | March | April | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Ac.ft. | Ac.ft. | Ac.ft. | Ac.ft. | Ac.ft. | Ac.ft. | Ac.ft. | Ac.ft. | Ac.ft. |
| 1961 | ----- | 1,000 | 1,000 | 3,000 | 4,000 | ----- | ----- | ----- | 9,000 |
| 1962 | 4,500 | ----- | ----- | 2,000 | 2,000 | 2,000 | 3,000 | 3,000 | 16,500 |
| 1963 | ----- | ----- | 1,000 | 2,000 | 3,500 | 3,000 | 1,000 | ----- | 10,500 |

TABLE 7.--Project water pumped from Groundwater Reservoir, Watershed F-1

| Year | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| 1960 | 1,000 | 2,500 | 3,500 | 3,000 | 1,000 | 500 | 11,500 |
| 1961 | 3,000 | 5,000 | 5,000 | 3,000 | ----- | --- | 16,000 |
| 1962 | ----- | 5,000 | 5,000 | ----- | ----- | --- | 10,000 |
| 1963 | 3,000 | 5,000 | 5,000 | 1,500 | ----- | --- | 14,500 |

Delay networks were used to simulate groundwater routing in the models for Sub-basins F and E. However, they introduced errors by the disproportionate increase of the volume of water routed. Consequently, the outflow from these models as well as the groundwater storage were erroneous and the project effects on these items could not be determined with confidence. Therefore, the downstream project effects are not summarized here.

# CHAPTER III

## SUB-BASIN E ANALOG MODEL

### DESCRIPTION OF THE MODEL

Two analog models were programmed for areas within Sub-basin E: (1) All of Watersheds E-1 and 2, and (2) the portion of Watershed E-5 in the Paria River drainage designated E-5A. The model for Watersheds E-1 and 2 required estimating so much input data that no significant results were obtained. Therefore, that model will not be discussed here.

The circuitry used to formulate the model of Watershed E-5A was essentially the same as for the Sub-basin F models. Again, two types of data were used to describe the area being modeled: (1) That for which the values do not change once the model has been calibrated, and (2) that for which the values change monthly. These are listed in Tables 8 and 9. Data for the average water supply year is also included as programmed. The outflow data used as a check in calibrating this model was the total outflow from the watershed and no attempt was made to separate the volume of groundwater flow from the surface-water flow.

### CONDITIONS INVESTIGATED

A series of irrigation efficiencies were programmed for each of the years of data input. These efficiencies for the Watershed E-5A model were 30 percent (present), 40 percent, 50 percent and 60 percent.

A potential project was programmed which would increase the overall irrigation efficiency to the 50 percent level. This would require importation of water from the East Fork of the Sevier River to overcome any deficit. The water importation required is shown in Table 10.

TABLE 8.--Hydrologic factors of constant value for Watershed E-5A model

| Description of factor | Potentiometer number | Actual value | Potentiometer setting[a] |
|---|---|---|---|
| Tributary watershed area (acres) | | 64,490 | |
| Cropland area (acres) | | 2,170 | |
| Wetland area (acres) | | 460 | |
| Soil moisture-holding capacity (inches) | | | |
| Tributary watershed[b] | 5 | 7 | 17.5 |
| Cropland | 31 | 9.84 | 24.6 |
| Canal irrigation efficiency (percent) | 33 | 30 | 15.0 |
| Percent of cropland in grain | 53 | 7 | 3.5 |
| Percent of cropland in alfalfa | 54 | 84 | 42.0 |
| Percent of cropland in irrigated pasture | 55 | 9 | 4.5 |
| Runoff threshold (inches)[b] | 10 | 3 | 0.47[c] |
| Percent of deep percolation | | | |
| Tributary runoff[b] | 21 | 75 | 37.5 |
| Percent of quick return flow | | | |
| Tributary runoff[b] | 22 | 25 | 12.5 |
| Time delay-deep percolation routing[b] | | 6.4 months | |
| Time delay-quick return flow routing[b] | | 1 month | |

[a]Arm voltage when high side of potentiometer was connected to 50 volts.

[b]Values determined by trial and error during calibration.

[c]Potentiometer dial setting.

TABLE 9.--Monthly type input data for Watershed E-5A Model, 1960

| | Valley precipitation | | Mountain day-time hours | | Valley day-time hours | | Valley temperature | | Canal diversions | | Tropic Canal | | Groundwater inflow | | Outflow[a] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.63 | 6.3 | 6.90 | 3.45 | | 20.91 | 21.5 | 10.8 | 0 | 0 | 0 | 0 | 32 | 6.4 | 194 | 7.76 |
| 2 | 0.88 | 8.8 | 6.81 | 3.40 | | 20.60 | 27.9 | 14.0 | 0 | 0 | 0 | 0 | 32 | 6.4 | 139 | 5.56 |
| 3 | 0 | 0 | 8.34 | 4.17 | | 25.27 | 41.6 | 20.8 | 97 | 3.88 | 0 | 0 | 32 | 6.4 | 116 | 4.64 |
| 4 | 0.74 | 7.4 | 8.89 | 4.44 | | 26.91 | 47.5 | 23.8 | 194 | 7.76 | 0 | 0 | 51 | 10.2 | 69 | 2.76 |
| 5 | 0.19 | 1.9 | 9.89 | 4.94 | | 29.94 | 54.7 | 27.4 | 425 | 17.00 | 464 | 18.56 | 79 | 15.8 | 434 | 17.36 |
| 6 | 0.91 | 9.1 | 9.92 | 4.96 | | 30.06 | 65.1 | 32.6 | 295 | 11.80 | 624 | 24.96 | 60 | 12.0 | 305 | 12.20 |
| 7 | 0.11 | 1.1 | 10.07 | 5.04 | | 30.54 | 72.2 | 36.1 | 143 | 5.72 | 162 | 6.48 | 46 | 9.2 | 180 | 7.20 |
| 8 | 0.55 | 5.5 | 9.45 | 4.72 | | 28.60 | 68.4 | 34.2 | 120 | 4.80 | 0 | 0 | 46 | 9.2 | 152 | 6.08 |
| 9 | 1.45 | 14.5 | 8.38 | 4.19 | | 25.39 | 62.8 | 31.4 | 102 | 4.08 | 0 | 0 | 37 | 7.4 | 125 | 5.00 |
| 10 | 2.75 | 27.5 | 7.81 | 3.90 | | 23.63 | 48.6 | 24.3 | 102 | 4.08 | 0 | 0 | 42 | 8.4 | 120 | 4.80 |
| 11 | 1.20 | 12.0 | 6.85 | 3.42 | | 20.72 | 40.1 | 20.0 | 102 | 4.08 | 0 | 0 | 42 | 8.4 | 97 | 3.88 |
| 12 | 0.40 | 4.0 | 6.69 | 3.34 | | 20.24 | 33.8 | 16.9 | 0 | 0 | 0 | 0 | 37 | 7.4 | 203 | 8.12 |

| | Grain $k_c$ | | Alfalfa $k_c$ | | Irrigated pasture $k_c$ | | Wet area $k_c$ | | Mountain $k_c$ | | Mountain temperature | | Mountain precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.25 | 6.25 | 0.68 | 17.00 | 0.48 | 12.00 | 0.76 | 11.40 | 0.49 | 12.25 | 17.7 | 8.8 | 0.81 | 8.1 | | |
| 2 | 0.25 | 6.25 | 0.79 | 19.75 | 0.57 | 14.25 | 0.85 | 12.75 | 0.58 | 14.50 | 22.4 | 11.2 | 1.67 | 16.7 | | |
| 3 | 0.25 | 6.25 | 0.89 | 22.25 | 0.73 | 18.25 | 1.09 | 16.35 | 0.75 | 18.75 | 36.7 | 18.4 | 0.19 | 1.9 | | |
| 4 | 0.25 | 6.25 | 0.99 | 24.75 | 0.85 | 21.25 | 1.26 | 18.90 | 0.87 | 21.75 | 43.4 | 21.7 | 0.46 | 4.6 | | |
| 5 | 0.53 | 13.25 | 1.08 | 27.00 | 0.90 | 22.50 | 1.34 | 20.10 | 0.92 | 23.00 | 50.6 | 25.3 | 0.27 | 2.7 | | |
| 6 | 1.55 | 38.75 | 1.11 | 27.75 | 0.92 | 23.00 | 1.38 | 20.70 | 0.94 | 23.50 | 61.4 | 30.7 | 0.68 | 6.8 | | |
| 7 | 1.13 | 28.25 | 1.10 | 27.50 | 0.92 | 23.00 | 1.42 | 21.30 | 0.94 | 23.50 | 67.6 | 33.8 | 0.29 | 2.9 | | |
| 8 | 0.25 | 6.25 | 1.08 | 27.00 | 0.91 | 22.75 | 1.45 | 21.75 | 0.93 | 23.25 | 64.6 | 32.3 | 0.77 | 7.7 | | |
| 9 | 0.25 | 6.25 | 1.01 | 25.25 | 0.87 | 21.75 | 1.41 | 21.15 | 0.89 | 22.25 | 59.4 | 29.7 | 2.22 | 22.2 | | |
| 10 | 0.25 | 6.25 | 0.92 | 23.00 | 0.80 | 20.00 | 1.32 | 19.80 | 0.82 | 20.50 | 45.2 | 22.6 | 2.58 | 25.8 | | |
| 11 | 0.25 | 6.25 | 0.81 | 20.25 | 0.67 | 16.75 | 1.14 | 17.10 | 0.69 | 17.25 | 36.2 | 18.1 | 1.51 | 15.1 | | |
| 12 | 0.25 | 6.25 | 0.69 | 17.25 | 0.55 | 13.75 | 0.90 | 13.50 | 0.56 | 14.00 | 28.2 | 14.1 | 0.67 | 6.7 | | |

[a] Outflow value is an estimation based on 46.2 percent of Average Annual Water Budget.

TABLE 9 continued

1961

| | Valley precipitation | | Valley temperature | | Canal diversions | | Tropic Canal | | Groundwater inflow | | Outflow[a] | | Mountain temperature | | Mountain precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0.23 | 2.3 | 31.6 | 15.8 | 0 | 0 | 0 | 0 | 36 | 7.2 | 216 | 8.64 | 27.5 | 13.8 | 0.26 | 2.6 |
| 2 | 0.02 | 0.2 | 37.0 | 18.5 | 0 | 0 | 0 | 0 | 36 | 7.2 | 154 | 6.16 | 32.6 | 16.3 | 0.21 | 2.1 |
| 3 | 1.66 | 16.6 | 38.7 | 19.4 | 108 | 4.32 | 0 | 0 | 36 | 7.2 | 128 | 5.12 | 34.2 | 17.1 | 1.73 | 17.3 |
| 4 | 0.97 | 9.7 | 45.6 | 22.8 | 216 | 8.64 | 6 | 0.24 | 57 | 11.4 | 77 | 3.08 | 42.2 | 21.1 | 0.82 | 8.2 |
| 5 | 0.88 | 8.8 | 53.3 | 26.6 | 472 | 18.88 | 566 | 22.64 | 87 | 17.4 | 482 | 19.28 | 49.6 | 24.8 | 0.67 | 6.7 |
| 6 | 0.09 | 0.9 | 67.0 | 33.5 | 328 | 13.12 | 788 | 31.52 | 67 | 13.4 | 338 | 13.52 | 62.8 | 31.4 | 0.07 | 0.7 |
| 7 | 3.04 | 30.4 | 69.4 | 34.7 | 159 | 6.36 | 335 | 13.40 | 51 | 10.2 | 200 | 8.00 | 66.1 | 33.0 | 2.30 | 23.0 |
| 8 | 3.79 | 37.9 | 66.6 | 33.3 | 133 | 5.32 | 83 | 3.32 | 51 | 10.2 | 169 | 6.76 | 63.5 | 31.8 | 4.14 | 41.4 |
| 9 | 2.00 | 20.0 | 56.1 | 28.0 | 113 | 4.52 | 342 | 13.68 | 41 | 8.2 | 139 | 5.56 | 52.2 | 26.2 | 3.54 | 35.4 |
| 10 | 0.52 | 5.2 | 50.3 | 25.6 | 113 | 4.52 | 349 | 13.96 | 46 | 9.2 | 133 | 5.32 | 45.2 | 22.6 | 0.61 | 6.1 |
| 11 | 0.65 | 6.5 | 38.3 | 19.2 | 113 | 4.52 | 0 | 0 | 46 | 9.2 | 108 | 4.32 | 33.6 | 16.8 | 0.45 | 4.5 |
| 12 | 0.78 | 7.8 | 26.0 | 13.0 | 0 | 0 | 0 | 0 | 41 | 8.2 | 226 | 9.04 | 22.6 | 11.3 | 0.99 | 9.9 |

1962

| | Precipitation | | Valley temperature | | Canal diversions | | Tropic Canal | | Groundwater inflow | | Outflow[b] | | Mountain temperature | | Mountain precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 1.69 | 16.9 | 27.1 | 13.6 | 0 | 0 | 0 | 0 | 70 | 14.0 | 420 | 16.8 | 24.0 | 12.0 | 0.78 | 7.8 |
| 2 | 2.42 | 24.2 | 37.8 | 18.9 | 0 | 0 | 0 | 0 | 70 | 14.0 | 300 | 12.0 | 31.8 | 15.9 | 2.89 | 28.9 |
| 3 | 0.85 | 8.5 | 33.0 | 16.5 | 210 | 8.40 | 0 | 0 | 70 | 14.0 | 250 | 10.0 | 28.0 | 14.0 | 1.21 | 12.1 |
| 4 | 0.20 | 2.0 | 50.0 | 25.0 | 420 | 16.80 | 182 | 7.28 | 110 | 22.0 | 150 | 6.0 | 46.6 | 23.3 | 0.11 | 1.1 |
| 5 | 0.51 | 5.1 | 49.4 | 24.7 | 920 | 36.80 | 788 | 31.52 | 170 | 34.0 | 940 | 37.6 | 46.7 | 23.4 | 0.86 | 8.6 |
| 6 | 0.38 | 3.8 | 61.0 | 30.5 | 640 | 25.60 | 915 | 36.60 | 130 | 26.0 | 660 | 26.4 | 57.6 | 28.8 | 1.34 | 13.4 |
| 7 | 0.50 | 5.0 | 65.7 | 32.8 | 310 | 12.40 | 919 | 36.76 | 100 | 20.0 | 390 | 15.6 | 62.7 | 31.4 | 0.51 | 5.1 |
| 8 | 0.31 | 3.1 | 65.5 | 32.8 | 260 | 10.40 | 468 | 18.72 | 100 | 20.0 | 330 | 13.2 | 62.8 | 31.4 | 0.08 | 0.8 |
| 9 | 2.25 | 22.5 | 58.9 | 29.4 | 220 | 8.80 | 0 | 0 | 80 | 16.0 | 270 | 10.8 | 56.7 | 28.4 | 2.07 | 20.7 |
| 10 | 1.42 | 14.2 | 50.0 | 25.0 | 220 | 8.80 | 0 | 0 | 90 | 18.0 | 260 | 10.4 | 47.2 | 23.6 | 1.84 | 18.4 |
| 11 | 0.18 | 1.8 | 38.3 | 19.2 | 220 | 8.80 | 0 | 0 | 90 | 18.0 | 210 | 8.4 | 37.0 | 18.5 | 0.15 | 1.5 |
| 12 | 0.48 | 4.8 | 31.9 | 16.0 | 0 | 0 | 0 | 0 | 80 | 16.0 | 440 | 17.6 | 29.0 | 14.5 | 0.62 | 6.2 |

[a] Outflow value is an estimation based on 51.3 percent of Average Annual Water Budget.

[b] Outflow value "estimated" to be the same as for Average Annual Water Budget.

TABLE 9 continued

Average annual

| | Valley precipitation | | Valley temperature | | Canal diversions | | Tropic Canal | | Groundwater inflow | | Outflow | | Mountain temperature | | Mountain precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 1.01 | 10.1 | 28.1 | 14.05 | 0 | 0 | 0 | 0 | 70 | 14.0 | 420 | 16.8 | 35.1 | 12.55 | 1.31 | 13.1 |
| 2 | 0.81 | 8.1 | 31.5 | 15.75 | 0 | 0 | 0 | 0 | 70 | 14.0 | 300 | 12.0 | 28.5 | 14.00 | 1.29 | 12.9 |
| 3 | 0.94 | 9.4 | 38.0 | 19.00 | 210 | 8.4 | 0 | 0 | 70 | 14.0 | 250 | 10.0 | 35.0 | 17.50 | 1.48 | 14.8 |
| 4 | 0.63 | 6.3 | 46.6 | 23.30 | 350 | 14.0 | 120 | 4.8 | 110 | 22.0 | 150 | 6.0 | 43.6 | 21.80 | 0.94 | 9.4 |
| 5 | 0.48 | 4.8 | 54.4 | 27.20 | 830 | 33.2 | 830 | 33.2 | 170 | 34.0 | 940 | 37.6 | 51.4 | 25.70 | 0.78 | 7.8 |
| 6 | 0.51 | 5.1 | 62.4 | 31.20 | 600 | 24.0 | 840 | 33.6 | 130 | 26.0 | 660 | 26.4 | 59.4 | 29.70 | 0.59 | 5.9 |
| 7 | 0.83 | 8.3 | 68.7 | 34.35 | 310 | 12.4 | 660 | 26.4 | 100 | 20.0 | 390 | 14.6 | 65.7 | 32.85 | 1.12 | 11.2 |
| 8 | 1.46 | 14.6 | 66.6 | 33.30 | 260 | 10.4 | 560 | 22.4 | 100 | 20.0 | 330 | 13.2 | 63.3 | 31.65 | 1.98 | 19.8 |
| 9 | 0.98 | 9.8 | 60.6 | 30.30 | 220 | 8.8 | 420 | 16.8 | 80 | 16.0 | 270 | 10.8 | 57.6 | 28.80 | 1.43 | 14.3 |
| 10 | 1.18 | 11.8 | 50.0 | 25.00 | 220 | 8.8 | 190 | 7.6 | 90 | 18.0 | 260 | 10.4 | 47.0 | 23.50 | 1.52 | 15.2 |
| 11 | 0.55 | 5.5 | 38.3 | 19.15 | 220 | 8.8 | 0 | 0 | 90 | 18.0 | 210 | 8.4 | 35.3 | 17.65 | 0.99 | 9.9 |
| 12 | 1.04 | 10.4 | 31.9 | 15.95 | 0 | 0 | 0 | 0 | 80 | 16.0 | 440 | 17.6 | 28.9 | 14.45 | 12.8 | 12.8 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |

TABLE 10.--Total water importation required from the East Fork of the Sevier River for no deficit at 50 percent irrigation efficiency

| Year | April | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| | ac.ft. | ac.ft. | ac.ft. | ac.ft. | ac.ft. | ac.ft. | ac.ft. | ac.ft. |
| 1960 | 1,250 | 1,250 | 1,000 | 1,000 | 1,000 | 1,000 | -- | 6,500 |
| 1961 | 500 | 750 | 750 | 750 | 750 | 400 | 350 | 4,250 |
| 1962 | 180 | 790 | 910 | 920 | 470 | -- | -- | 3,270 |
| Average year | 120 | 830 | 1,000 | 750 | 750 | 420 | 190 | 4,060 |

## SUMMARY OF RESULTS

Tables 11, 12 and 13 show some of the on-site effects of increasing irrigation efficiencies for the study years. Figure 6 is a plot of the data in Table 13 and presents generalized curves relating cropland root zone deficit with irrigation efficiency. The variation in the slope of the curves for the different years is directly related to the precipittion variations. These curves can be used to estimate the on-site effect of any project which increases the overall irrigation efficiency. The downstream project effects are not summarized here because of the errors introduced by the delay networks as described for the Sub-basin F model.

Experience with the Sub-basin E and F models has shown that adequate simulation of the water-yielding area was hampered by scanty data and limited analog equipment. As a result, later models use all available analog equipment to simulate the cropland, wetland, and groundwater reservoir portions of the study areas. Runoff estimated from yield maps then becomes input data. It was also necessary to develop a different type of circuit to simulate the groundwater reservoirs and their interaction with the river system.

TABLE 11.--Cropland root zone deficit or surplus as computed in the analog model

| Irrigation efficiency | Average annual water supply | 1960 | 1961 | 1962 |
|---|---|---|---|---|
| Percent | | | | |
| 30 | -1,650 | -3,310 | -1,530 | -1,210 |
| 40 | -950 | -3,160 | -1,180 | -450 |
| 50 | -250 | -2,940 | -690 | 0 |
| 60 | +450 | -2,590 | -330 | 0 |

TABLE 12.--Change in cropland soil moisture storage

| Irrigation efficiency | Average annual water supply | 1960 | 1961 | 1962 |
|---|---|---|---|---|
| Percent | | | | |
| 30 | 0 | +10 | -170 | -90 |
| 40 | 0 | +40 | -190 | -100 |
| 50 | 0 | +60 | -200 | +100 |
| 60 | 0 | +80 | -130 | +780 |

TABLE 13.--Actual deficit - Root zone supply minus potential consumptive use

| Irrigation efficiency | Average annual water supply | 1960 | 1961 | 1962 |
|---|---|---|---|---|
| Percent | | | | |
| 30 | -1,650 | -3,300 | -1,700 | -1,300 |
| 40 | -950 | -3,120 | -1,370 | -550 |
| 50 | -250 | -2,880 | -890 | +100 |
| 60 | +450 | -2,510 | -460 | +780 |

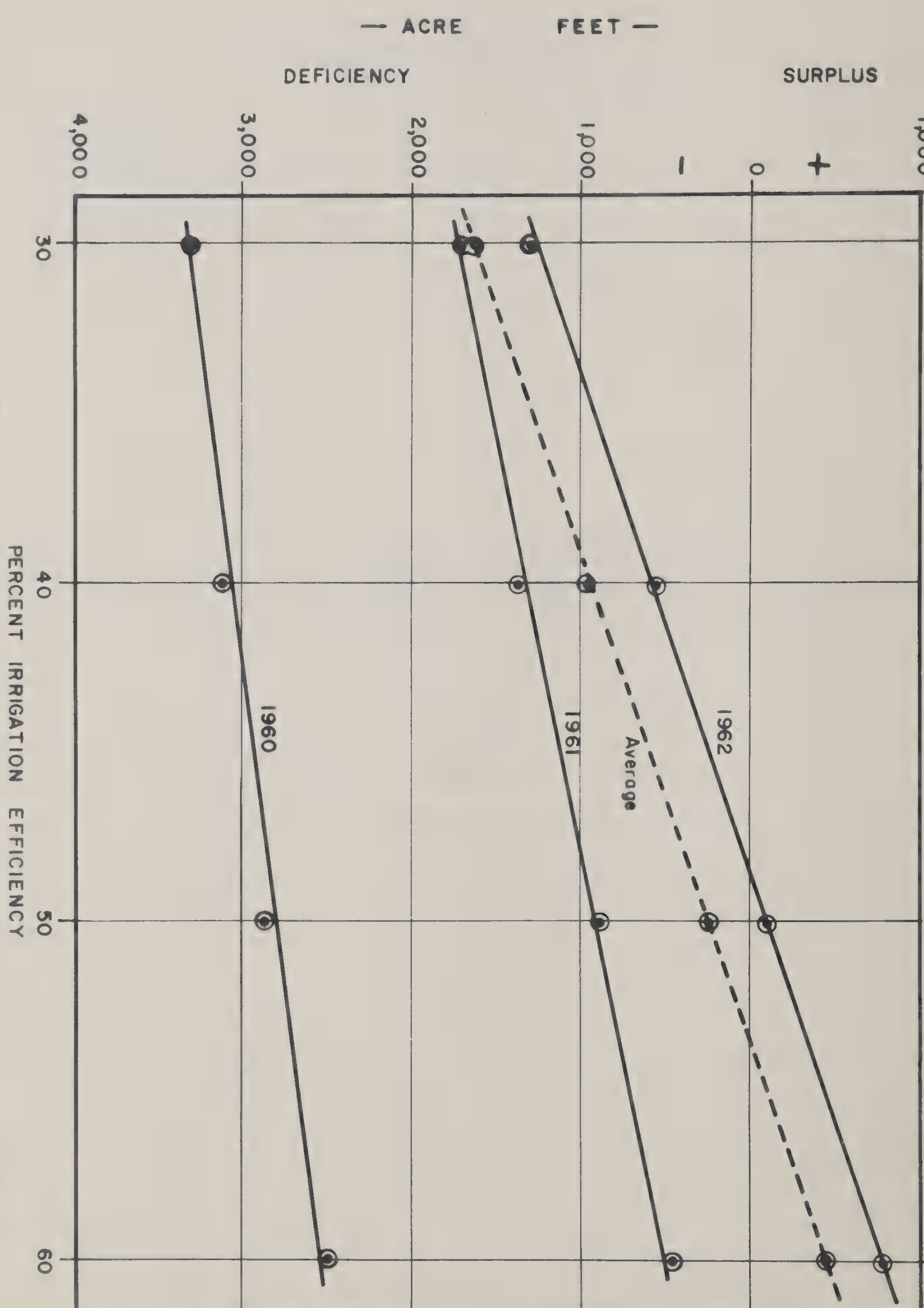



Figure 6
Root Zone Deficit – Surplus vs. Efficiency
Watershed E-5A Analog Model
Sevier River Basin
Utah

# CHAPTER IV

## SUB-BASINS D AND C ANALOG MODELS

### DESCRIPTION OF THE MODELS

Based on the experience gained in Sub-basins F and E, all of the analog equipment was used to model the valley portions of Sub-basins D and C. Two separate models were designed for these sub-basins although the circuitry used to formulate each of these models was essentially the same. Circuits were formulated to represent the cropland area, wetland area and groundwater reservoir for each of the two models.

The Sub-basin D model consisted of three cropland areas: (1) Watersheds D-1 and 5, (2) Watersheds D-2 and 3, (3) Watershed D-4; the combined wetland area; and the combined groundwater reservoir. The Sub-basin C model consisted of three cropland areas: (1) Watershed C-2, (2) Watershed C-3, (3) Watersheds C-1, 4, 5 and 6; the combined wetland area; and the combined groundwater reservoir.

The tributary runoff was determined from average annual yield maps and correlated with streamflow gage records to represent each specific year. The surface water tributary inflow was routed through the respective watershed cropland areas and a specified percentage diverted into the irrigation systems for use on the cropland. The groundwater tributary inflow was routed directly to the groundwater reservoir of the model. The average precipitation on the cropland of Watersheds D-1 and 5 was an input into the model and was adjusted as necessary for the other areas.

Input data whose values do not change once the model has been calibrated are listed in Tables 14a and 14b. Variable input data is shown in Tables 15a and 15b. Data for a series of four years (1960 through 1963) was programmed for these two models. The year 1960 was programmed primarily to establish more accurate initial conditions. The following three years were used for evaluating potential project effects.

The outflow past the Sigurd gage was used to calibrate the Sub-basin D model. This included the recorded flow of the Sevier River plus the estimated canal and groundwater outflows. The outflow, both surface and groundwater, from the Sevier Bridge Reservoir was used to calibrate the Sub-basin C model.

TABLE 14a.--Hydrologic factors of constant value for Sub-basin D model

| Description of factor | Potentiometer number | Actual value | Potentiometer setting[a] |
|---|---|---|---|
| Cropland area (acres) | | | |
| Watersheds D-1 and 5 | | 21,710 | |
| Watersheds D-2 and 3 | | 1,810 | |
| Watershed D-4 | | 11,090 | |
| Wetland total (acres) | | 11,510 | |
| Cropland soil moisture-holding capacity (inches) | | | |
| Watersheds D-1 and 5 | 25 | 9.5 | 23.75 |
| Watersheds D-2 and 3 | 32 | 7.9 | 19.75 |
| Watershed D-4 | 27 | 8.3 | 20.75 |
| Canal water irrigation efficiency (percent) | | | |
| Watersheds D-1 and 5 | 2 | 36 | 18.0 |
| Watersheds D-2 and 3 | 6 | 33 | 16.5 |
| Watershed D-4 | 4 | 32 | 16.0 |
| Pumped water irrigation efficiency (percent) | | | |
| Watersheds D-1 and 5 | 52 | 40 | 20.0 |
| Watersheds D-2 and 3 | 64 | 36 | 18.0 |
| Watershed D-4 | 56 | 40 | 20.0 |
| Percent of surface flow tributary runoff | | | |
| Watersheds D-1 and 5[b] | 15 | 52 | 26.0 |
| Watersheds D-2 and 3[b] | 19 | 87.6 | 43.8 |
| Watershed D-4[b] | 17 | 96.5 | 48.25 |
| Percent of groundwater tributary runoff | | | |
| Watersheds D-1 and 5[b] | 16 | 48 | 24.0 |
| Watersheds D-2 and 3[b] | 20 | 12.4 | 6.2 |
| Watershed D-4[b] | 18 | 3.5 | 1.75 |
| Percent of surface runoff diverted | | | |
| Watersheds D-1 and 5 | 22 | 58.6 | 29.3 |
| Watersheds D-2 and 3 | 24 | 70.8 | 35.4 |
| Watershed D-4 | 23 | 81.3 | 40.65 |
| Precipitation adjustment | | | |
| Watersheds D-2 and 3 | 29 | 0.718 | 35.9 |
| Wetland | 30 | 1.089 | 13.05[c] |
| Flow from groundwater storage | 69 | .15 | 7.5 |
| Initial groundwater basin storage voltage[b] | | 26.0 | |

[a] Arm voltage when high side of potentiometer was connected to 50 volts.
[b] Data was determined by trial and error during calibration of the model.
[c] This factor was combined with an acreage adjustment factor.

TABLE 14b.--Hydrologic factors of constant value for Sub-basin C model

| Description of factor | Potentiometer number | Actual value | Potentiometer setting[a] |
|---|---|---|---|
| Cropland area (acres) | | | |
| Watershed C-2 | | 16,540 | |
| Watershed C-3 | | 15,670 | |
| Watersheds C-1, 4, 5 and 6 | | 9,370 | |
| Wetland total (acres) | | 18,740 | |
| Cropland soil moisture-holding capacity (inches) | | | |
| Watershed C-2 | 25 | 10.43 | 26.07 |
| Watershed C-3 | 27 | 10.64 | 26.6 |
| Watersheds C-1, 4, 5 and 6 | 32 | 10.16 | 25.4 |
| Canal water irrigation efficiency (percent) | | | |
| Watershed C-2 | 2 | 30 | 15.0 |
| Watershed C-3 | 4 | 30 | 15.0 |
| Watersheds C-1, 4 5 and 6 | 7 | 28 | 14.0 |
| Pumped water irrigation efficiency (percent) | | | |
| Watershed C-2 | 52 | 40 | 20.0 |
| Watershed C-3 | 56 | 45 | 22.5 |
| Watersheds C-1, 4, 5 and 6 | 64 | 40 | 20.0 |
| Percent of surface flow tributary runoff | | | |
| Watershed C-3[b] | 17 | 95 | 47.5 |
| Watersheds C-1, 4, 5 and 6[b] | 19 | 75 | 37.5 |
| Percent of groundwater tributary runoff | | | |
| Watershed C-3[b] | 18 | 5 | 2.5 |
| Watersheds C-1, 4, 5 and 6[b] | 20 | 25 | 12.5 |
| Percent of surface runoff diverted | | | |
| Watershed C-3[b] | 23 | 50 | 25.0 |
| Precipitation adjustment | | | |
| Watersheds C-2 and 3 | 54 | 1.164 | 29.1 |
| Watersheds C-1, 4, 5 and 6 | 29 | 1.102 | 27.6 |
| Wetland | 30 | 1.122 | 21.9[c] |
| Flow from groundwater storage[b] | 68 | 0.17 | 8.5 |
| Initial groundwater basin storage voltage[b] | | 30 | |

[a]Arm voltage when high side of potentiometer is connected to 50 volts.

[b]This data was determined by trial and error during calibration of the model.

[c]This factor was combined with an acreage adjustment factor.

TABLE 15a - Monthly type input data for Sub-basin D Model, 1960

| | TRO[a] D-1 & 5 | | TRO[a] D-4 | | TRO[a] D-2 & 3 | | Canal diversions D-1 & 5 | | Canal diversions D-4 | | Canal diversions D-2 & 3 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/100 Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 250 | 2.50 | 290 | 2.90 | 200 | 2.00 | 850 | 1.70 | 300 | 0.60 | --- | --- | 1,720 | 1.72 | 0.53 | 5.3 |
| 2 | 250 | 2.50 | 280 | 2.80 | 190 | 1.90 | 810 | 1.62 | 290 | 0.58 | --- | --- | 1,790 | 1.79 | 1.15 | 11.5 |
| 3 | 640 | 6.40 | 740 | 7.40 | 500 | 5.00 | 470 | 0.94 | 650 | 1.30 | --- | --- | 13,360 | 13.36 | 0.78 | 7.8 |
| 4 | 980 | 9.80 | 1,120 | 11.20 | 760 | 7.60 | 3,480 | 6.96 | 3,120 | 6.24 | 1,070 | 10.7 | 15,740 | 15.74 | 0.32 | 3.2 |
| 5 | 1,840 | 18.40 | 2,110 | 21.10 | 1,440 | 14.40 | 9,980 | 19.96 | 5,160 | 10.32 | 1,090 | 10.9 | 23,420 | 23.42 | 0.85 | 8.5 |
| 6 | 1,530 | 15.30 | 1,760 | 17.60 | 1,200 | 12.00 | 8,260 | 16.52 | 4,920 | 9.84 | 1,070 | 10.7 | 17,550 | 17.55 | 0.01 | 0.1 |
| 7 | 270 | 2.70 | 320 | 3.20 | 210 | 2.10 | 8,250 | 16.50 | 5,090 | 10.18 | 1,090 | 10.9 | 14,700 | 14.70 | 0.76 | 7.6 |
| 8 | 180 | 1.80 | 200 | 2.00 | 130 | 1.30 | 5,560 | 11.12 | 4,000 | 8.00 | 1,090 | 10.9 | 9,150 | 9.15 | 0.18 | 1.8 |
| 9 | 220 | 2.20 | 250 | 2.50 | 170 | 1.70 | 2,650 | 5.30 | 910 | 1.82 | 1,070 | 10.7 | 4,450 | 4.45 | 1.17 | 11.7 |
| 10 | 210 | 2.10 | 240 | 2.40 | 170 | 1.70 | 2,270 | 4.54 | 2,070 | 4.14 | 780 | 7.8 | 3,820 | 3.82 | 1.16 | 11.6 |
| 11 | 250 | 2.50 | 290 | 2.90 | 200 | 2.00 | 2,280 | 8.56 | 3,180 | 6.36 | --- | --- | 4,910 | 4.91 | 0.70 | 7.0 |
| 12 | 220 | 2.20 | 250 | 2.50 | 170 | 1.70 | 1,270 | 2.54 | 780 | 1.56 | --- | --- | 1,130 | 1.13 | 0.09 | 0.9 |

| | Temperature | | Daytime hours | | Cropland $k_c$ | | Wet area $k_c$ | | Pumped water D-2 & 3 | | Pumped water D-4 | | Pumped water D-1 & 5 | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | 3.03 Volts | Actual Value | 25 Volts | Actual Value | 25 Volts | Actual Value | 1/100 Volts | Actual Value | 1/200 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts |
| 1 | 27.0 | 13.50 | 6.82 | 20.66 | 0.50 | 12.50 | 0.85 | 21.25 | --- | --- | --- | --- | --- | --- | 4,250 | 4.25 |
| 2 | 29.8 | 14.90 | 6.77 | 20.51 | 0.56 | 14.00 | 0.89 | 22.25 | --- | --- | --- | --- | --- | --- | 7,420 | 7.42 |
| 3 | 41.3 | 20.65 | 8.32 | 25.21 | 0.63 | 15.75 | 0.93 | 23.25 | --- | --- | --- | --- | --- | --- | 12,280 | 12.28 |
| 4 | 48.6 | 24.30 | 8.91 | 27.00 | 0.69 | 17.25 | 10.7 | 26.75 | --- | --- | --- | --- | 290 | 0.58 | 11,390 | 11.39 |
| 5 | 55.4 | 27.70 | 9.95 | 30.15 | 0.89 | 22.25 | 1.07 | 26.75 | 689 | 6.89 | --- | --- | 290 | 0.58 | 10,420 | 10.42 |
| 6 | 65.6 | 32.80 | 10.00 | 30.30 | 1.17 | 29.25 | 1.14 | 28.50 | 567 | 5.67 | --- | --- | 310 | 0.62 | 7,660 | 7.66 |
| 7 | 71.3 | 35.65 | 10.15 | 30.75 | 1.05 | 26.25 | 1.21 | 30.25 | 515 | 5.15 | --- | --- | 360 | 0.72 | 6,350 | 6.35 |
| 8 | 68.4 | 34.20 | 9.50 | 28.79 | 0.86 | 21.50 | 1.33 | 33.25 | 492 | 4.92 | --- | --- | 320 | 0.64 | 4,050 | 4.05 |
| 9 | 62.8 | 31.40 | 8.39 | 25.42 | 0.79 | 19.75 | 1.32 | 33.00 | 232 | 2.32 | --- | --- | 320 | 0.64 | 3,120 | 3.12 |
| 10 | 49.2 | 24.60 | 7.80 | 23.63 | 0.65 | 16.25 | 1.28 | 32.00 | 141 | 1.41 | --- | --- | 290 | 0.58 | 3,750 | 3.75 |
| 11 | 39.3 | 19.65 | 6.78 | 20.54 | 0.58 | 14.50 | 1.36 | 34.00 | --- | --- | --- | --- | --- | --- | 3,560 | 3.56 |
| 12 | 28.8 | 14.40 | 6.61 | 20.03 | 0.51 | 12.75 | 1.03 | 25.75 | --- | --- | --- | --- | --- | --- | 3,340 | 3.34 |

[a] TRO = Tributary Runoff from the water yielding area.

TABLE 15a continued

1961

| | TRO D-1 & 5 | | TRO D-4 | | TRO D-2 & 3 | | Canal diversions D-1 & 5 | | Canal diversions D-4 | | Canal diversions D-2 & 3 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/100 Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 210 | 2.10 | 240 | 2.40 | 160 | 1.60 | 900 | 1.80 | 250 | 0.50 | --- | --- | 1,170 | 1.17 | 0.37 | 3.7 |
| 2 | 230 | 2.30 | 260 | 2.60 | 180 | 1.80 | 840 | 1.68 | 250 | 0.50 | --- | --- | 2,770 | 2.77 | 0.78 | 7.8 |
| 3 | 380 | 3.80 | 440 | 4.40 | 300 | 3.00 | 660 | 1.32 | 2,630 | 5.26 | --- | --- | 9,780 | 9.78 | 1.61 | 16.1 |
| 4 | 720 | 7.20 | 830 | 8.30 | 560 | 5.60 | 420 | 0.84 | 1,840 | 3.68 | 1,070 | 10.7 | 7,220 | 7.22 | 1.57 | 15.7 |
| 5 | 1,820 | 18.20 | 2,070 | 20.70 | 1,420 | 14.20 | 12,160 | 24.32 | 5,930 | 11.86 | 1,090 | 10.9 | 24,180 | 24.18 | 0.32 | 3.2 |
| 6 | 1,070 | 10.70 | 1,230 | 12.30 | 830 | 8.30 | 7,820 | 15.64 | 4,300 | 8.60 | 1,070 | 10.7 | 15,740 | 15.74 | 0.11 | 1.1 |
| 7 | 350 | 3.50 | 400 | 4.00 | 270 | 2.70 | 5,940 | 11.88 | 3,980 | 7.96 | 1,090 | 10.9 | 12,770 | 12.77 | 0.39 | 3.9 |
| 8 | 340 | 3.40 | 380 | 3.80 | 260 | 2.60 | 2,770 | 5.54 | 2,880 | 5.76 | 1,090 | 10.9 | 6,660 | 6.66 | 1.38 | 13.8 |
| 9 | 400 | 4.00 | 460 | 4.60 | 320 | 3.20 | 2,410 | 4.82 | 1,630 | 3.26 | 1,070 | 10.7 | 3,830 | 3.83 | 2.31 | 23.1 |
| 10 | 380 | 3.80 | 440 | 4.40 | 300 | 3.00 | 5,770 | 11.54 | 3,890 | 7.78 | 780 | 7.8 | 11,300 | 11.30 | 0.55 | 5.5 |
| 11 | 270 | 2.70 | 320 | 3.20 | 220 | 2.20 | 2,830 | 5.66 | 2,710 | 5.42 | --- | --- | 5,310 | 5.31 | 0.62 | 6.2 |
| 12 | 250 | 2.50 | 290 | 2.90 | 200 | 2.00 | 1,290 | 2.58 | 520 | 1.04 | --- | --- | 2,010 | 2.01 | 0.41 | 4.1 |

| | Temperature | | Daytime hours | | Cropland $k_c$ | | Wetland area $k_c$ | | Pumped water D-2 & 3 | | Pumped water D-4 | | Pumped water D-1 & 5 | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | 3.03 Volts | Actual Value | 25 Volts | Actual Value | 25 Volts | Actual Value | 1/100 Volts | Actual Value | Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts |
| 1 | 26.9 | 13.45 | 6.82 | 20.66 | 0.50 | 12.50 | 0.85 | 21.25 | --- | --- | --- | --- | --- | --- | 4,180 | 4.18 |
| 2 | 36.8 | 18.40 | 6.77 | 20.51 | 0.56 | 14.00 | 0.88 | 22.00 | --- | --- | --- | --- | --- | --- | 5,480 | 5.48 |
| 3 | 38.8 | 19.40 | 8.32 | 25.21 | 0.63 | 15.75 | 0.95 | 23.75 | --- | --- | --- | --- | --- | --- | 9,150 | 9.15 |
| 4 | 46.7 | 23.35 | 8.91 | 27.00 | 0.69 | 17.25 | 0.98 | 24.50 | --- | --- | --- | --- | 290 | 0.58 | 8,640 | 8.64 |
| 5 | 55.8 | 27.90 | 9.95 | 30.15 | 0.89 | 22.25 | 1.06 | 26.50 | 282 | 2.82 | --- | --- | 290 | 0.58 | 9,270 | 8.27 |
| 6 | 67.4 | 33.70 | 10.00 | 30.30 | 1.17 | 29.25 | 1.11 | 27.75 | 457 | 4.57 | --- | --- | 310 | 0.62 | 7,440 | 7.44 |
| 7 | 71.2 | 35.60 | 10.15 | 30.75 | 1.05 | 26.25 | 1.21 | 30.25 | 358 | 3.58 | --- | --- | 360 | 0.72 | 5,220 | 5.22 |
| 8 | 69.6 | 34.80 | 9.50 | 28.79 | 0.86 | 21.50 | 1.21 | 30.25 | 271 | 2.71 | --- | --- | 320 | 0.64 | 2,790 | 2.79 |
| 9 | 55.5 | 27.75 | 8.39 | 25.42 | 0.79 | 19.75 | 1.35 | 33.75 | 333 | 3.33 | --- | --- | 320 | 0.64 | 2,210 | 2.21 |
| 10 | 48.0 | 24.00 | 7.80 | 23.63 | 0.65 | 16.25 | 1.31 | 32.75 | 23 | 0.23 | --- | --- | 290 | 0.58 | 5,760 | 5.76 |
| 11 | 33.3 | 16.65 | 6.78 | 20.54 | 0.58 | 14.50 | 1.48 | 37.00 | 2 | 2.00 | --- | --- | --- | --- | 4,630 | 4.63 |
| 12 | 28.8 | 14.40 | 6.61 | 20.03 | 0.51 | 12.75 | 1.01 | 25.25 | --- | --- | --- | --- | --- | --- | 4,150 | 4.15 |

TABLE 15a continued

1962

| | TRO D-1 & 5 | | TRO D-4 | | TRO D-2 & 3 | | Canal diversions D-1 & 5 | | Canal diversions D-4 | | Canal diversions D-2 & 3 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/100 Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 260 | 2.60 | 300 | 3.00 | 210 | 2.10 | 890 | 1.78 | 250 | 0.50 | --- | --- | 2,100 | 2.10 | 0.63 | 6.30 |
| 2 | 500 | 5.00 | 570 | 5.70 | 390 | 3.90 | 620 | 1.24 | 190 | 0.38 | --- | --- | 2,700 | 2.70 | 2.23 | 22.3 |
| 3 | 440 | 4.40 | 500 | 5.00 | 340 | 3.40 | 600 | 1.20 | 530 | 1.06 | --- | --- | 2,520 | 2.52 | 0.23 | 2.30 |
| 4 | 2,250 | 22.50 | 2,570 | 25.70 | 1,750 | 17.50 | 4,090 | 8.18 | 4,070 | 8.14 | 1,070 | 10.7 | 10,130 | 10.13 | 0.88 | 8.80 |
| 5 | 2,260 | 22.60 | 2,600 | 26.00 | 1,770 | 17.70 | 12,340 | 24.68 | 5,440 | 10.88 | 1,090 | 10.9 | 25,720 | 25.72 | 1.00 | 10.00 |
| 6 | 2,640 | 26.40 | 3,030 | 30.30 | 2,060 | 20.60 | 10,760 | 21.52 | 6,990 | 13.98 | 1,070 | 10.7 | 27,580 | 27.58 | 0.13 | 1.30 |
| 7 | 960 | 9.60 | 1,110 | 11.10 | 750 | 7.50 | 13,490 | 26.98 | 8,380 | 16.76 | 1,090 | 10.9 | 31,510 | 31.51 | 0.76 | 7.60 |
| 8 | 260 | 2.60 | 300 | 3.00 | 210 | 2.10 | 10,810 | 21.62 | 8,250 | 16.50 | 1,090 | 10.9 | 24.790 | 24.79 | 0.07 | 0.70 |
| 9 | 220 | 2.20 | 260 | 2.60 | 170 | 1.70 | 5,680 | 11.36 | 3,510 | 7.02 | 1,070 | 10.7 | 15,220 | 15.22 | 0.93 | 9.30 |
| 10 | 260 | 2.60 | 300 | 3.00 | 210 | 2.10 | 2,730 | 5.46 | 2,200 | 4.40 | 780 | 7.8 | 5,970 | 5.97 | 0.42 | 4.20 |
| 11 | 300 | 3.00 | 340 | 3.40 | 230 | 2.30 | 2,770 | 5.54 | 3,050 | 6.10 | --- | --- | 6,170 | 6.17 | 0.28 | 2.80 |
| 12 | 230 | 2.30 | 270 | 2.70 | 180 | 1.80 | 1,690 | 3.38 | 1,630 | 3.26 | --- | --- | 3,130 | 3.13 | 0.33 | 3.30 |

| | Temperature | | Daytime hours | | Cropland $k_c$ | | Wetland $k_c$ | | Pumped water D-2 & 3 | | Pumped water D-4 | | Pumped water D-1 & 5 | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | 3.03 Volts | Actual Value | 25 Volts | Actual Value | 25 Volts | Actual Value | 1/100 Volts | Actual Value | 1/200 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts |
| 1 | 20.6 | 10.30 | 6.82 | 20.66 | 0.50 | 12.50 | 0.85 | 21.25 | --- | --- | --- | --- | --- | --- | 5,050 | 5.05 |
| 2 | 32.7 | 16.35 | 6.77 | 20.51 | 0.56 | 14.00 | 0.89 | 22.25 | --- | --- | --- | --- | --- | --- | 6,630 | 6.63 |
| 3 | 33.3 | 16.65 | 8.32 | 25.21 | 0.63 | 15.75 | 1.00 | 25.00 | --- | --- | --- | --- | --- | --- | 5,530 | 5.53 |
| 4 | 50.0 | 25.00 | 8.91 | 27.00 | 0.69 | 17.25 | 0.95 | 23.75 | --- | --- | --- | --- | 290 | 0.58 | 5,680 | 5.68 |
| 5 | 52.8 | 26.40 | 9.95 | 30.15 | 0.89 | 22.25 | 1.05 | 26.25 | 345 | 3.45 | --- | --- | 290 | 0.58 | 11,230 | 11.23 |
| 6 | 61.9 | 30.95 | 10.00 | 30.30 | 1.17 | 29.25 | 1.12 | 28.00 | 380 | 3.80 | --- | --- | 310 | 0.62 | 13,060 | 13.06 |
| 7 | 68.5 | 34.25 | 10.15 | 30.75 | 1.05 | 26.25 | 1.22 | 30.50 | 355 | 3.55 | --- | --- | 360 | 0.72 | 11,830 | 11.83 |
| 8 | 67.5 | 33.75 | 9.50 | 28.79 | 0.86 | 21.50 | 1.33 | 33.25 | 302 | 3.02 | --- | --- | 320 | 0.64 | 9,180 | 9.18 |
| 9 | 61.5 | 30.75 | 8.39 | 25.42 | 0.79 | 19.75 | 1.35 | 33.75 | 278 | 2.78 | --- | --- | 320 | 0.64 | 8,920 | 8.92 |
| 10 | 50.2 | 25.10 | 7.80 | 23.63 | 0.65 | 16.25 | 1.30 | 32.50 | 141 | 1.41 | --- | --- | 290 | 0.58 | 5,910 | 5.91 |
| 11 | 41.2 | 20.60 | 6.78 | 20.54 | 0.58 | 14.50 | 1.34 | 33.50 | --- | --- | --- | --- | --- | --- | 5,150 | 5.15 |
| 12 | 27.8 | 13.90 | 6.61 | 20.03 | 0.51 | 12.75 | 1.01 | 25.25 | --- | --- | --- | --- | --- | --- | 4,450 | 4.45 |

TABLE 15a continued



| | TRO D-1 & 5 | | TRO D-4 | | TRO D-2 & 3 | | Canal diversions D-1 & 5 | | Canal diversions D-4 | | Canal diversions D-2 & 3 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | 1/100 Volts | Actual Value | Volts | Actual Value | 1/500 Volts | Actual Value | Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 260 | 2.60 | 300 | 3.00 | 210 | 2.10 | 650 | 1.30 | 320 | 0.64 | --- | --- | 1,150 | 1.15 | 0.43 | 4.30 |
| 2 | 280 | 2.80 | 3.30 | 3.30 | 220 | 2.20 | 530 | 1.06 | 480 | 0.96 | --- | --- | 5,600 | 5.60 | 0.35 | 3.50 |
| 3 | 330 | 3.30 | 370 | 3.70 | 250 | 2.50 | 820 | 1.64 | 2,930 | 5.86 | --- | --- | 13,580 | 13.58 | 0.86 | 8.60 |
| 4 | 320 | 3.20 | 360 | 3.60 | 250 | 2.50 | 1,030 | 2.06 | 2,090 | 4.18 | 1,070 | 10.7 | 8,830 | 8.83 | 0.66 | 6.60 |
| 5 | 1,130 | 11.30 | 1,300 | 13.00 | 890 | 8.90 | 11,410 | 22.82 | 5,290 | 10.58 | 1,090 | 10.9 | 21,040 | 21.04 | 0.17 | 1.70 |
| 6 | 870 | 8.70 | 1,000 | 10.00 | 680 | 6.80 | 4,560 | 9.12 | 2,770 | 5.54 | 1,070 | 10.7 | 8,880 | 8.88 | 0.53 | 5.30 |
| 7 | 280 | 2.80 | 330 | 3.30 | 220 | 2.20 | 7,920 | 15.84 | 5,220 | 10.44 | 1,090 | 10.9 | 15,890 | 15.89 | 0.62 | 6.20 |
| 8 | 260 | 2.60 | 310 | 3.10 | 210 | 2.10 | 4,340 | 8.68 | 3,380 | 6.76 | 1,090 | 10.9 | 9,440 | 9.44 | 1.96 | 19.60 |
| 9 | 240 | 2.40 | 270 | 2.70 | 190 | 1.90 | 2,220 | 4.44 | 1,740 | 3.48 | 1,070 | 10.7 | 4,090 | 4.09 | 0.66 | 6.60 |
| 10 | 210 | 2.10 | 240 | 2.40 | 160 | 1.60 | 2,950 | 5.90 | 2,220 | 4.44 | 780 | 7.8 | 5,670 | 5.67 | 0.35 | 3.50 |
| 11 | 230 | 2.30 | 260 | 2.60 | 180 | 1.80 | 2,300 | 4.60 | 3,170 | 6.34 | --- | --- | 4,510 | 4.51 | 0.78 | 7.80 |
| 12 | 190 | 1.90 | 210 | 2.10 | 140 | 1.40 | 900 | 1.80 | 680 | 1.36 | --- | --- | 1,670 | 1.67 | 0.11 | 1.10 |

| | Temperature | | Daytime hours | | Cropland $k_c$ | | Wetland $k_c$ | | Pumped water D-2 & 3 | | Pumped water D-4 | | Pumped water D-1 & 5 | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | 25 Volts | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | Volts |
| 1 | 23.4 | 11.70 | 6.82 | 20.66 | 0.50 | 12.50 | 0.85 | 21.25 | --- | --- | --- | --- | --- | --- | 4,130 | 4.13 |
| 2 | 37.7 | 18.85 | 6.77 | 20.51 | 0.56 | 14.00 | 0.86 | 21.50 | --- | --- | --- | --- | --- | --- | 8,350 | 8.35 |
| 3 | 36.3 | 18.15 | 8.32 | 25.21 | 0.63 | 15.75 | 0.99 | 24.75 | --- | --- | --- | --- | --- | --- | 11,480 | 11.48 |
| 4 | 42.5 | 21.25 | 8.91 | 27.00 | 0.69 | 17.25 | 1.08 | 27.00 | 198 | 1.98 | --- | --- | 290 | 0.58 | 9,140 | 9.14 |
| 5 | 58.6 | 29.30 | 9.95 | 30.15 | 0.89 | 22.25 | 1.05 | 26.25 | 387 | 3.87 | --- | --- | 290 | 0.58 | 8,230 | 8.23 |
| 6 | 61.6 | 30.80 | 10.00 | 30.30 | 1.17 | 29.25 | 1.14 | 28.50 | 441 | 4.41 | --- | --- | 310 | 0.62 | 4,720 | 4.72 |
| 7 | 71.0 | 35.50 | 10.15 | 30.75 | 1.05 | 26.25 | 1.24 | 31.00 | 351 | 3.51 | --- | --- | 360 | 0.72 | 6,510 | 6.51 |
| 8 | 70.2 | 35.10 | 9.50 | 28.79 | 0.86 | 21.50 | 1.27 | 31.75 | 195 | 1.95 | --- | --- | 320 | 0.64 | 3,430 | 3.43 |
| 9 | 63.5 | 31.75 | 8.39 | 25.42 | 0.79 | 19.75 | 1.29 | 32.25 | 426 | 4.26 | --- | --- | 320 | 0.64 | 2,580 | 2.58 |
| 10 | 54.0 | 27.00 | 7.80 | 23.63 | 0.65 | 16.25 | 1.26 | 31.50 | 51 | 0.51 | --- | --- | 290 | 0.58 | 4,400 | 4.40 |
| 11 | 39.7 | 19.85 | 6.78 | 20.54 | 0.58 | 14.50 | 1.35 | 33.75 | --- | --- | --- | --- | --- | --- | 3,760 | 3.76 |
| 12 | 25.5 | 12.75 | 6.61 | 20.03 | 0.51 | 12.75 | 1.01 | 25.25 | --- | --- | --- | --- | --- | --- | 3,660 | 3.66 |

TABLE 15b.—Original monthly type input data for Sub-basin C Model, 1960

| | TRO C-2 | | TRO[a] C-3 | | TRO[a] C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal Diversions C-1,4,5,6 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 610 | 6.1 | 870 | 1.74 | 1,530 | 3.06 | 500 | 1.00 | --- | --- | 770 | 1.54 | 4,510 | 4.51 | 0.51 | 5.1 |
| 2 | 640 | 6.4 | 810 | 1.62 | 2,250 | 4.50 | 580 | 1.16 | --- | --- | 1,360 | 2.72 | 7,680 | 7.68 | 1.48 | 14.8 |
| 3 | 670 | 6.7 | 1,130 | 2.26 | 2,180 | 4.36 | 1,240 | 2.48 | --- | --- | 1,640 | 3.28 | 12,570 | 12.57 | 0.88 | 8.8 |
| 4 | 930 | 9.3 | 2,630 | 5.26 | 5,480 | 10.96 | 6,620 | 13.24 | 2,290 | 4.58 | 5,450 | 10.90 | 13,810 | 13.81 | 0.67 | 6.7 |
| 5 | 1,430 | 14.3 | 7,800 | 15.60 | 11,640 | 23.28 | 7,940 | 15.88 | 9,360 | 18.72 | 9,190 | 18.38 | 12,110 | 12.11 | 0.90 | 9.0 |
| 6 | 1,030 | 10.3 | 5,550 | 11.10 | 7,280 | 14.56 | 8,470 | 16.94 | 4,050 | 8.10 | 5,660 | 11.32 | 10,340 | 10.34 | 0.00 | 0.0 |
| 7 | 760 | 7.6 | 2,670 | 5.34 | 3,670 | 7.34 | 8,120 | 16.24 | 3,720 | 7.44 | 3,670 | 7.34 | 10,690 | 10.69 | T | 0.0 |
| 8 | 700 | 7.0 | 1,740 | 3.48 | 2,710 | 5.42 | 5,170 | 10.34 | 1,460 | 2.92 | 2,530 | 5.06 | 4,710 | 4.71 | 0.00 | 0.0 |
| 9 | 650 | 6.5 | 1,390 | 2.78 | 2,190 | 4.38 | 4,130 | 8.26 | 1,140 | 2.28 | 2,210 | 4.42 | 3,670 | 3.67 | 1.12 | 11.2 |
| 10 | 640 | 6.4 | 1,140 | 2.28 | 1,950 | 3.90 | 4,540 | 9.08 | 570 | 1.14 | 1,990 | 3.98 | 4,070 | 4.07 | 1.20 | 12.0 |
| 11 | 600 | 6.0 | 950 | 1.90 | 1,610 | 3.22 | 2,470 | 4.94 | --- | --- | 2,010 | 4.02 | 3,820 | 3.82 | 1.06 | 10.6 |
| 12 | 620 | 6.2 | 820 | 1.64 | 1,660 | 3.32 | 540 | 1.08 | --- | --- | 1,070 | 2.14 | 3,600 | 3.60 | 0.00 | 0.0 |

| | Temperature (Salina) | | Daytime hours 39° | | Cropland $k_c$ | | Wetland $k_c$ | | Pumped water C-2 | | Pumped water C-3 | | Change in reservoir storage | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | 3.03 Volts | Actual Value | 25 Volts | Actual Value | 25 Volts | Actual Value | 1/200 Volts | Actual Value | 1/200 Volts | Actual Value | 1/200 + 20V Volts | Actual Value | 1/1000 Volts |
| 1 | 25.9 | 12.95 | 6.80 | 20.60 | 0.53 | 13.25 | 0.88 | 22.00 | --- | --- | --- | --- | +9,440 | 24.72 | 300 | 0.30 |
| 2 | 28.8 | 14.40 | 6.76 | 20.48 | 0.61 | 15.25 | 0.89 | 22.25 | --- | --- | --- | --- | +12,180 | 26.09 | 300 | 0.30 |
| 3 | 41.4 | 20.70 | 8.32 | 25.21 | 0.68 | 17.00 | 0.91 | 22.75 | --- | --- | --- | --- | +15,340 | 27.67 | 350 | 0.35 |
| 4 | 49.9 | 24.95 | 8.91 | 27.00 | 0.75 | 18.75 | 1.02 | 25.50 | --- | --- | --- | --- | -5,070 | 17.46 | 12,890 | 12.89 |
| 5 | 57.0 | 28.50 | 9.96 | 30.18 | 0.87 | 21.75 | 1.04 | 26.00 | 190 | 0.95 | 90 | 0.45 | -34,670 | 2.66 | 43,350 | 43.35 |
| 6 | 67.4 | 33.70 | 10.02 | 30.36 | 1.13 | 28.25 | 1.13 | 28.25 | 180 | 0.90 | 90 | 0.45 | -15,010 | 12.50 | 20,370 | 20.37 |
| 7 | 73.6 | 36.80 | 10.17 | 30.82 | 1.10 | 27.50 | 1.21 | 30.25 | 190 | 0.95 | 90 | 0.45 | -14,020 | 12.99 | 14,330 | 14.33 |
| 8 | 68.9 | 34.45 | 9.51 | 28.82 | 0.92 | 23.00 | 1.30 | 32.50 | 190 | 0.95 | 90 | 0.45 | 0 | 20.00 | 3,480 | 3.48 |
| 9 | 62.7 | 31.35 | 8.39 | 25.42 | 0.83 | 20.75 | 1.31 | 32.75 | 180 | 0.90 | 90 | 0.45 | +1,810 | 20.91 | 2,300 | 2.30 |
| 10 | 47.7 | 23.85 | 7.79 | 23.60 | 0.71 | 17.75 | 1.26 | 31.50 | --- | --- | --- | --- | +4,710 | 22.35 | 180 | 0.18 |
| 11 | 38.3 | 19.15 | 6.77 | 20.51 | 0.63 | 15.75 | 1.30 | 32.50 | --- | --- | --- | --- | +6,580 | 23.29 | 200 | 0.20 |
| 12 | 26.6 | 13.30 | 6.60 | 20.00 | 0.54 | 13.50 | 1.04 | 26.00 | --- | --- | --- | --- | +7,440 | 23.72 | 220 | 0.22 |

[a] TRO = Tributary Runoff from the water yielding area.

TABLE 15b continued 1961

| | TRO C-2 | | TRO C-3 | | TRO C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal diversions C-1,4,5,6 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 570 | 5.7 | 820 | 1.64 | 1,140 | 2.28 | 1,000 | 2.00 | --- | --- | 720 | 1.44 | 4,420 | 4.42 | 0.25 | 2.5 |
| 2 | 570 | 5.7 | 830 | 1.66 | 1,330 | 2.66 | 840 | 1.68 | --- | --- | 690 | 1.38 | 5,730 | 5.73 | 0.64 | 6.4 |
| 3 | 600 | 6.0 | 1,030 | 2.06 | 1,290 | 2.58 | 2,570 | 5.14 | --- | --- | 1,740 | 3.48 | 9,420 | 9.42 | 1.65 | 16.5 |
| 4 | 780 | 7.8 | 1,620 | 3.24 | 3,470 | 6.94 | 5,010 | 8.02 | 2,040 | 4.08 | 3,560 | 7.12 | 9,620 | 9.62 | 2.17 | 21.7 |
| 5 | 1,100 | 11.1 | 5,250 | 10.50 | 7,610 | 15.22 | 9,820 | 19.64 | 4,030 | 8.06 | 7,780 | 15.56 | 12,740 | 12.74 | 0.41 | 4.1 |
| 6 | 840 | 8.4 | 3,550 | 7.10 | 3,870 | 7.74 | 7,980 | 15.96 | 1,800 | 3.60 | 4,460 | 8.92 | 9,940 | 9.94 | 0.00 | 0.0 |
| 7 | 670 | 6.7 | 2,110 | 4.22 | 1,920 | 3.84 | 6,190 | 12.38 | 1,090 | 2.18 | 2,550 | 5.10 | 6,290 | 6.29 | 0.67 | 6.7 |
| 8 | 630 | 6.3 | 1,570 | 3.14 | 1,770 | 3.54 | 3,180 | 7.56 | 1,080 | 2.16 | 2,550 | 5.10 | 3,230 | 3.23 | 1.42 | 14.2 |
| 9 | 590 | 5.9 | 1,420 | 2.84 | 1,980 | 3.96 | 3,470 | 6.94 | 1,050 | 2.10 | 2,230 | 4.46 | 2,610 | 2.61 | 2.45 | 24.5 |
| 10 | 590 | 5.9 | 1,380 | 2.76 | 2,050 | 4.10 | 5,630 | 11.26 | 530 | 1.06 | 2,290 | 4.58 | 6,010 | 6.01 | 1.38 | 13.8 |
| 11 | 560 | 5.6 | 1,240 | 2.48 | 1,390 | 2.78 | 2,440 | 4.88 | --- | --- | 920 | 1.84 | 4,880 | 4.88 | 1.43 | 14.3 |
| 12 | 580 | 5.8 | 1,110 | 2.22 | 1,380 | 2.76 | 980 | 1.96 | --- | --- | 790 | 1.58 | 4,390 | 4.39 | 0.26 | 2.6 |

| | Temperature | | Daytime hours 39° | | Cropland $k_c$ | | Wetland $k_c$ | | Pumped water C-2 | | Pumped water C-3 | | Change in reservoir storage | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | 3.03 Volts | Actual Value | 25 Volts | Actual Value | 25 Volts | Actual Value | 1/200 Volts | Actual Value | 1/200 Volts | Actual Value | 1/2000 + 20v Volts | Actual Value | 1/1000 Volts |
| 1 | 25.7 | 12.85 | 6.80 | 20.60 | 0.53 | 13.25 | 0.88 | 22.00 | --- | --- | --- | --- | +8,040 | 24.02 | 240 | 0.24 |
| 2 | 34.6 | 17.30 | 6.76 | 20.48 | 0.61 | 15.25 | 0.88 | 22.00 | --- | --- | --- | --- | +8,540 | 24.27 | 230 | 0.23 |
| 3 | 37.3 | 18.65 | 8.32 | 25.21 | 0.68 | 17.00 | 0.94 | 23.50 | --- | --- | --- | --- | +12,290 | 26.15 | 250 | 0.25 |
| 4 | 45.2 | 22.60 | 8.91 | 27.00 | 0.75 | 18.75 | 0.95 | 23.75 | --- | --- | --- | --- | +9,200 | 24.60 | 240 | 0.24 |
| 5 | 55.8 | 27.90 | 9.96 | 30.18 | 0.87 | 21.75 | 1.02 | 25.50 | 190 | 0.95 | 90 | 0.45 | -36.190 | 1.90 | 40,420 | 40.42 |
| 6 | 68.3 | 34.15 | 10.02 | 30.36 | 1.13 | 28.25 | 1.10 | 27.50 | 180 | 0.90 | 90 | 0.45 | -10,210 | 14.90 | 12,600 | 12.60 |
| 7 | 74.2 | 37.10 | 10.17 | 30.82 | 1.10 | 27.50 | 1.21 | 30.25 | 190 | 0.95 | 90 | 0.45 | -9,450 | 15.27 | 11,180 | 11.18 |
| 8 | 72.3 | 36.15 | 9.51 | 28.82 | 0.92 | 23.00 | 1.23 | 30.75 | 190 | 0.95 | 90 | 0.45 | -720 | 19.64 | 3,730 | 3.73 |
| 9 | 57.7 | 28.85 | 8.39 | 25.42 | 0.83 | 20.75 | 1.32 | 33.00 | 180 | 0.90 | 90 | 0.45 | +3,350 | 21.68 | 200 | 0.19 |
| 10 | 47.5 | 23.75 | 7.79 | 23.60 | 0.71 | 17.75 | 1.30 | 32.50 | --- | --- | --- | --- | +5,040 | 22.52 | 190 | 0.19 |
| 11 | 32.9 | 16.45 | 6.77 | 20.51 | 0.63 | 15.75 | 1.39 | 34.75 | --- | --- | --- | --- | +7,310 | 23.65 | 190 | 0.19 |
| 12 | 27.0 | 13.50 | 6.60 | 20.00 | 0.54 | 13.50 | 1.02 | 25.50 | --- | --- | --- | --- | +7,930 | 23.97 | 180 | 0.18 |

TABLE 15b continued

1962

| | TRO C-2 | | TRO C-3 | | TRO C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal diversions C-1,4,5,6 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 660 | 6.6 | 1,080 | 2.16 | 1,810 | 3.62 | 1,040 | 20.8 | --- | --- | 1,140 | 2.28 | 5,450 | 5.45 | 0.71 | 7.1 |
| 2 | 720 | 7.2 | 1,080 | 2.16 | 3,400 | 6.80 | 800 | 1.60 | --- | --- | 950 | 1.90 | 7,040 | 7.04 | 2.49 | 24.9 |
| 3 | 740 | 7.4 | 1,260 | 2.52 | 3,290 | 6.58 | 1,760 | 3.52 | --- | --- | 1,050 | 2.10 | 5,970 | 5.97 | 0.71 | 7.1 |
| 4 | 1,120 | 11.2 | 5,700 | 11.40 | 11,200 | 22.44 | 5,640 | 11.28 | 3,400 | 6.80 | 6,850 | 13.70 | 9,920 | 9.92 | 1.14 | 11.4 |
| 5 | 1,820 | 18.2 | 12,790 | 25.58 | 17,010 | 34.02 | 10,530 | 21.06 | 6,280 | 12.56 | 9,870 | 19.74 | 15,950 | 15.95 | 1.19 | 11.9 |
| 6 | 1,260 | 12.6 | 11,750 | 23.50 | 11,000 | 22.00 | 9,050 | 18.10 | 5,400 | 10.80 | 8,910 | 17.82 | 16,930 | 16.93 | 0.07 | 0.7 |
| 7 | 880 | 8.8 | 5,420 | 10.84 | 5,460 | 10.92 | 11,000 | 22.00 | 6,370 | 12.74 | 6,450 | 12.90 | 18,950 | 18.95 | 0.32 | 3.2 |
| 8 | 790 | 7.9 | 2,360 | 4.72 | 3,550 | 7.10 | 7,750 | 15.50 | 5,410 | 10.82 | 4,680 | 9.36 | 15,180 | 15.18 | 0.10 | 1.0 |
| 9 | 730 | 7.3 | 1,630 | 3.26 | 2,600 | 5.20 | 4,140 | 8.28 | 4,110 | 8.22 | 2,800 | 2.60 | 13,750 | 13.75 | 0.83 | 8.3 |
| 10 | 710 | 7.1 | 1,490 | 2.98 | 2,170 | 4.34 | 5,060 | 10.12 | 2,060 | 4.12 | 2,430 | 4.86 | 6,360 | 6.36 | 0.37 | 3.7 |
| 11 | 660 | 6.6 | 1,210 | 2.42 | 1,510 | 3.02 | 3,310 | 6.62 | --- | --- | 1,640 | 3.28 | 5,560 | 5.56 | 0.36 | 3.6 |
| 12 | 680 | 6.8 | 1,070 | 2.14 | 1,640 | 3.28 | 920 | 1.84 | --- | --- | 740 | 1.48 | 4,850 | 4.85 | 0.40 | 4.0 |

| | Temperature (Salina) | | Daytime hours 39° | | Cropland $k_c$ | | Wetland $k_c$ | | Pumped water C-2 | | Pumped water C-3 | | Change in reservoir storage | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | 3.03 Volts | Actual Value | 25 Volts | Actual Value | 25 Volts | Actual Value | 1/200 Volts | Actual Value | 1/200 Volts | Actual Value | Volts | Actual Value | 1/1000 Volts |
| 1 | 20.8 | 10.40 | 6.80 | 20.60 | 0.53 | 13.25 | 0.88 | 22.00 | --- | --- | --- | --- | +7,500 | 23.75 | 190 | 0.19 |
| 2 | 33.3 | 16.65 | 6.76 | 20.48 | 0.61 | 15.25 | 0.89 | 22.25 | --- | --- | --- | --- | +23,580 | 31.79 | 830 | 0.83 |
| 3 | 33.9 | 16.95 | 8.32 | 25.21 | 0.68 | 17.00 | 0.96 | 24.00 | --- | --- | --- | --- | +15,230 | 27.62 | 250 | 0.25 |
| 4 | 50.6 | 25.30 | 8.91 | 27.00 | 0.75 | 18.75 | 0.94 | 23.50 | --- | --- | --- | --- | +9,060 | 24.53 | 1,960 | 1.96 |
| 5 | 54.6 | 27.30 | 9.96 | 30.18 | 0.87 | 21.75 | 1.02 | 25.50 | 190 | 0.95 | 90 | 0.45 | -27,120 | 6.44 | 36,620 | 36.62 |
| 6 | 64.1 | 32.05 | 10.02 | 30.36 | 1.13 | 28.25 | 1.10 | 27.50 | 180 | 0.90 | 90 | 0.45 | -16,330 | 11.83 | 22,460 | 22.46 |
| 7 | 71.1 | 35.55 | 10.17 | 30.83 | 1.10 | 27.50 | 1.23 | 30.75 | 190 | 0.95 | 90 | 0.45 | -21,200 | 9.40 | 30,860 | 30.86 |
| 8 | 69.5 | 34.75 | 9.51 | 28.82 | 0.92 | 23.00 | 1.31 | 32.75 | 190 | 0.95 | 90 | 0.45 | -8,130 | 15.93 | 14,970 | 14.97 |
| 9 | 63.4 | 31.70 | 8.39 | 25.42 | 0.83 | 20.75 | 1.32 | 33.00 | 180 | 0.90 | 90 | 0.45 | +6,560 | 23.28 | 2,300 | 2.30 |
| 10 | 53.0 | 26.50 | 7.79 | 23.60 | 0.71 | 17.75 | 1.29 | 32.25 | --- | --- | --- | --- | +6,490 | 23.25 | 690 | 0.69 |
| 11 | 41.9 | 20.95 | 6.77 | 20.51 | 0.63 | 15.75 | 1.29 | 32.25 | --- | --- | --- | --- | +7,370 | 23.68 | 260 | 0.26 |
| 12 | 29.0 | 14.50 | 6.60 | 20.00 | 0.54 | 13.50 | 1.02 | 25.50 | --- | --- | --- | --- | +8,760 | 24.38 | 220 | 0.22 |

TABLE 15b continued

1963

| | TRO C-2 | | TRO C-3 | | TRO C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal diversions C-1,4,5,6 | | River inflow | | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts | Actual Value | 10 Volts |
| 1 | 570 | 5.7 | 1,040 | 2.08 | 1,480 | 2.96 | 1,030 | 2.06 | --- | --- | 530 | 1.06 | 4,300 | 4.30 | 0.71 | 7.1 |
| 2 | 560 | 5.6 | 1,030 | 2.06 | 2,900 | 5.80 | 900 | 1.80 | --- | --- | 530 | 1.06 | 8,520 | 8.52 | 0.70 | 7.0 |
| 3 | 600 | 6.0 | 1,170 | 2.34 | 1,390 | 2.78 | 2,490 | 4.98 | --- | --- | 1,750 | 3.50 | 11,670 | 11.67 | 0.57 | 5.7 |
| 4 | 770 | 7.7 | 1,480 | 2.96 | 2,780 | 5.56 | 5,080 | 10.16 | 2,910 | 5.82 | 2,710 | 5.42 | 12,260 | 12.26 | 0.70 | 7.0 |
| 5 | 1,090 | 10.9 | 6,710 | 13.42 | 7,150 | 14.30 | 8,970 | 17.94 | 2,550 | 5.10 | 6,840 | 13.68 | 13,060 | 13.06 | 0.09 | 0.9 |
| 6 | 830 | 8.3 | 4,440 | 8.88 | 4,900 | 9.80 | 5,440 | 10.88 | 2,720 | 5.44 | 4,640 | 9.28 | 7,670 | 7.67 | 0.58 | 5.8 |
| 7 | 660 | 6.6 | 2,480 | 4.96 | 2,800 | 5.60 | 8,360 | 16.72 | 4,800 | 9.60 | 3,850 | 7.70 | 12,030 | 12.03 | 0.30 | 3.0 |
| 8 | 620 | 6.2 | 1,950 | 3.90 | 2,000 | 4.00 | 5,090 | 10.18 | 4,960 | 9.92 | 2,700 | 5.40 | 8,880 | 8.88 | 0.89 | 8.9 |
| 9 | 590 | 5.9 | 1,430 | 2.86 | 1,670 | 3.34 | 3,670 | 7.34 | 4,960 | 9.92 | 2,000 | 4.00 | 3,690 | 3.69 | 1.26 | 12.6 |
| 10 | 590 | 5.9 | 1,190 | 2.38 | 1,640 | 3.28 | 5,650 | 11.30 | 1,120 | 2.24 | 2,390 | 4.78 | 4,580 | 4.58 | 0.65 | 6.5 |
| 11 | 560 | 5.6 | 1,060 | 2.12 | 1,430 | 2.86 | 3,080 | 6.16 | --- | --- | 1,780 | 3.56 | 3,930 | 3.93 | 0.76 | 7.6 |
| 12 | 570 | 5.7 | 1,090 | 2.18 | 1,450 | 2.90 | 1,300 | 2.60 | --- | --- | 760 | 1.52 | 3,830 | 3.83 | 0.26 | 2.6 |

| | Temperature (Salina) | | Daytime hours 39° | | Cropland $k_c$ | | Wetland $k_c$ | | Pumped water C-2 | | Pumped water C-3 | | Change in reservoir storage | | Outflow | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/2 Volts | Actual Value | 3.03 Volts | Actual Value | 25 Volts | Actual Value | 25 Volts | Actual Value | 1/200 Volts | Actual Value | 1/200 Volts | Actual Value | 1/2000 + 20V Volts | Actual Value | 1/1000 Volts |
| 1 | 20.6 | 10.30 | 6.80 | 20.60 | 0.53 | 13.25 | 0.88 | 22.00 | --- | --- | --- | --- | +9,000 | 24.50 | 190 | 0.19 |
| 2 | 38.7 | 19.35 | 6.76 | 20.48 | 0.61 | 15.25 | 0.88 | 22.00 | --- | --- | --- | --- | +13,740 | 26.87 | 250 | 0.25 |
| 3 | 38.5 | 19.25 | 8.32 | 25.21 | 0.68 | 17.00 | 0.96 | 24.00 | --- | --- | --- | --- | +12,460 | 26.23 | 250 | 0.25 |
| 4 | 44.9 | 22.45 | 8.91 | 27.00 | 0.75 | 18.75 | 1.02 | 25.50 | --- | --- | --- | --- | +3,010 | 21.50 | 4,010 | 4.01 |
| 5 | 61.1 | 30.55 | 9.96 | 30.18 | 0.87 | 21.75 | 1.02 | 25.50 | 190 | 0.95 | 90 | 0.45 | -40,310 | 0.00 | 43,130 | 43.13 |
| 6 | 62.8 | 31.40 | 10.02 | 30.36 | 1.13 | 28.25 | 1.13 | 28.25 | 180 | 0.90 | 90 | 0.45 | -6,460 | 16.77 | 9,990 | 9.99 |
| 7 | 74.7 | 37.35 | 10.17 | 30.82 | 1.10 | 27.50 | 1.23 | 30.75 | 190 | 0.95 | 90 | 0.45 | -13,260 | 13.37 | 13,260 | 13.26 |
| 8 | 73.0 | 36.50 | 9.51 | 28.82 | 0.92 | 23.00 | 1.26 | 31.50 | 190 | 0.95 | 90 | 0.45 | -4,330 | 17.83 | 6,670 | 6.67 |
| 9 | 66.0 | 33.00 | 8.39 | 25.42 | 0.83 | 20.75 | 1.29 | 32.25 | 180 | 0.90 | 90 | 0.45 | +3,390 | 21.70 | 320 | 0.32 |
| 10 | 56.4 | 28.20 | 7.79 | 23.60 | 0.71 | 17.75 | 1.25 | 31.25 | --- | --- | --- | --- | +3,380 | 21.69 | 320 | 0.32 |
| 11 | 41.0 | 20.50 | 6.77 | 20.51 | 0.63 | 15.75 | 1.30 | 32.50 | --- | --- | --- | --- | +5,720 | 22.86 | 280 | 0.28 |
| 12 | 25.7 | 12.85 | 6.60 | 20.00 | 0.54 | 13.50 | 1.02 | 25.50 | --- | --- | --- | --- | +7,960 | 23.98 | 250 | 0.25 |

In order to calibrate the Sub-basin C model, some extensive changes in the monthly input data were required. It was necessary to reduce the tributary runoff by 5.5 percent in all three sections of the model for each of the years programmed. The canal diversions to each of the three cropland areas had to be changed for all four years. The river inflow into Sub-basin C had to be changed in February and March of 1962, and in March, April and July of 1963. The revised data, as it was used, is shown in Table 16.

## CONDITIONS INVESTIGATED

A series of irrigation efficiencies were programmed for each of the years data input. The efficiencies were selected so that generalized relations could be developed to analyze the effect of specific projects such as land leveling, canal and ditch lining, or improved irrigation water management practices. The efficiencies programmed were:

| Watersheds D-1&5 | Watersheds D-2&3 | Watershed D-4 | Sub-basin C |
|---|---|---|---|
| 30% | 30% | 30% | 25% |
| 36%[a] | 33%[a] | 32%[a] | 30%[a] |
| 40% | 40% | 40% | 40% |
| 50% | 50% | 50% | 50% |

[a]Present efficiency

For both the Sub-basin D and Sub-basin C models, pumping projects were programmed to overcome the consumptive-use deficits on the cropland areas. However, the groundwater reservoir circuits of these models did not allow for a reduction in wetland consumptive use when the water table was lowered due to increased pumping. Consequently, the total effects of these projects were not reliable and are not summarized. The amount of pumping required to overcome the deficits can be obtained from Figures 7 and 8 for the respective sub-basins.

## SUMMARY OF RESULTS

Tables 17, 18 and 19 show some of the on-site effects of increasing irrigation efficiencies for the years programmed for the Sub-basin D model. Figure 7 is a plot of the data in Table 19. Tables 20, 21 and 22 and Figure 8 show corresponding data for the Sub-basin C model. The variation in slope of the curves for different years is due to variations in precipitation. A curve of average slope drawn through the deficit point as determined in the average annual water budgets produced a generalized curve relating cropland root zone deficit to irrigation efficiency. These were used to estimate the on-site effect of any project which increases the irrigation efficiency.

TABLE 16 - Revised monthly type input data for Sub-basin C Model, 1960

| | TRO C-2 | | TRO C-3 | | TRO C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal diversions C-1,4,5,6 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 600 | 6.0 | 820 | 1.64 | 1,500 | 3.00 | 500 | 1.00 | --- | --- | 770 | 1.54 | | | | |
| 2 | 610 | 6.1 | 810 | 1.62 | 2,200 | 4.40 | 580 | 1.16 | --- | --- | 1,360 | 2.72 | | | | |
| 3 | 630 | 6.3 | 900 | 1.80 | 2,100 | 4.20 | 1,240 | 2.48 | --- | --- | 1,640 | 3.28 | | | | |
| 4 | 840 | 8.4 | 2,400 | 4.80 | 5,100 | 10.20 | 7,000 | 14.00 | 2,800 | 5.60 | 5,450 | 10.90 | | | | |
| 5 | 1,360 | 13.6 | 7,700 | 15.40 | 11,500 | 23.00 | 7,940 | 15.88 | 8,350 | 16.70 | 8,200 | 16.40 | | | | |
| 6 | 940 | 9.4 | 5,300 | 10.60 | 6,900 | 13.80 | 8,600 | 17.20 | 4,050 | 8.10 | 5,800 | 11.60 | | | | |
| 7 | 700 | 7.0 | 23,50 | 4.70 | 3,300 | 6.60 | 8,620 | 17.24 | 4,220 | 8.44 | 5,000 | 10.00 | | | | |
| 8 | 670 | 6.7 | 1,600 | 3.20 | 2,400 | 4.80 | 5,200 | 10.40 | 1,460 | 2.92 | 2,650 | 5.30 | | | | |
| 9 | 640 | 6.4 | 1,300 | 2.60 | 2,000 | 4.00 | 4,100 | 8.20 | 1,140 | 2.28 | 2,210 | 4.42 | | | | |
| 10 | 620 | 6.2 | 1,100 | 2.20 | 1,800 | 3.60 | 4,000 | 8.00 | 570 | 1.14 | 1,800 | 3.60 | | | | |
| 11 | 600 | 6.0 | 900 | 1.80 | 1,500 | 3.00 | 2,000 | 4.00 | --- | --- | 1,600 | 3.20 | | | | |
| 12 | 590 | 5.9 | 820 | 1.64 | 1,300 | 2.60 | 540 | 1.08 | --- | --- | 1,070 | 2.14 | | | | |

1961

| | TRO C-2 | | TRO C-3 | | TRO C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal diversions C-1,4,5,6 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 570 | 5.7 | 750 | 1.50 | 1,100 | 2.20 | 1,000 | 2.00 | --- | --- | 720 | 1.44 | | | | |
| 2 | 560 | 5.6 | 750 | 1.50 | 1,150 | 2.30 | 1,000 | 2.00 | --- | --- | 1,000 | 2.00 | | | | |
| 3 | 580 | 5.8 | 1,000 | 2.00 | 1,200 | 2.40 | 2,000 | 4.00 | --- | --- | 1,250 | 2.50 | | | | |
| 4 | 710 | 7.1 | 1,600 | 3.20 | 3,400 | 6.80 | 3,500 | 7.00 | 2,040 | 4.08 | 3,000 | 6.00 | | | | |
| 5 | 1,000 | 10.0 | 5,000 | 10.00 | 7,300 | 14.60 | 9,820 | 19.64 | 4,030 | 8.06 | 8,000 | 16.00 | | | | |
| 6 | 760 | 7.6 | 3,300 | 6.60 | 3,500 | 7.00 | 8,000 | 16.00 | 2,800 | 5.60 | 5,500 | 11.00 | | | | |
| 7 | 650 | 6.5 | 1,900 | 3.80 | 1,800 | 3.60 | 6,700 | 13.40 | 2,100 | 4.20 | 3,000 | 6.00 | | | | |
| 8 | 600 | 6.0 | 1,500 | 3.00 | 1,700 | 3.40 | 3,780 | 7.56 | 1,080 | 2.16 | 2,550 | 5.10 | | | | |
| 9 | 570 | 5.7 | 1,400 | 2.80 | 1,900 | 3.80 | 3,000 | 6.00 | 1,050 | 2.10 | 1,800 | 3.60 | | | | |
| 10 | 570 | 5.7 | 1,300 | 2.60 | 1,950 | 3.90 | 4,630 | 9.26 | 530 | 1.06 | 2,200 | 4.40 | | | | |
| 11 | 560 | 5.6 | 1,200 | 2.40 | 1,300 | 2.60 | 2,440 | 4.88 | --- | --- | 920 | 1.84 | | | | |
| 12 | 570 | 5.7 | 1,000 | 2.00 | 1,300 | 2.60 | 980 | 1.96 | --- | --- | 790 | 1.58 | | | | |

TABLE 16 continued

1962

| | TRO C-2 | | TRO C-3 | | TRO C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal diversions C-1,4-6 | | River inflow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts | Actual Value | Volts |
| 1 | 590 | 5.9 | 1,000 | 2.00 | 1,100 | 2.20 | 1,040 | 2.08 | --- | --- | 1,140 | 2.28 | 5,450 | 5.45 | | |
| 2 | 1,200 | 12.0 | 5,400 | 10.80 | 9,650 | 19.30 | 800 | 1.60 | --- | --- | 950 | 1.90 | 11,040 | 11.04 | | |
| 3 | 900 | 9.0 | 2,900 | 5.80 | 5,000 | 10.00 | 1,760 | 3.52 | --- | --- | 1,050 | 2.10 | 6,970 | 6.97 | | |
| 4 | 1,050 | 10.5 | 5,600 | 11.20 | 11,200 | 22.40 | 5,640 | 11.28 | 3,400 | 6.80 | 6,850 | 13.70 | 9,920 | 9.92 | | |
| 5 | 1,320 | 13.2 | 9,500 | 19.00 | 12,450 | 24.90 | 10,530 | 21.06 | 6,280 | 12.56 | 9,870 | 19.74 | 15,950 | 15.95 | | |
| 6 | 900 | 9.0 | 8,500 | 17.00 | 7,300 | 14.60 | 10,050 | 20.10 | 6,400 | 12.80 | 9,000 | 18.00 | 16,930 | 16.93 | | |
| 7 | 820 | 8.2 | 5,250 | 10.50 | 5,200 | 10.40 | 10,000 | 20.00 | 6,370 | 12.74 | 6,450 | 12.90 | 18,950 | 18.95 | | |
| 8 | 750 | 7.5 | 1,800 | 3.60 | 2,700 | 5.40 | 7,750 | 15.50 | 5,410 | 10.82 | 4,680 | 9.36 | 15,180 | 15.18 | | |
| 9 | 720 | 7.2 | 1,300 | 2.60 | 2,050 | 4.10 | 5,140 | 10.28 | 4,110 | 8.22 | 3,000 | 6.00 | 13,750 | 13.75 | | |
| 10 | 700 | 7.0 | 1,100 | 2.20 | 1,800 | 3.60 | 4,060 | 8.12 | 2,060 | 4.12 | 2,000 | 4.00 | 6,360 | 6.36 | | |
| 11 | 650 | 6.5 | 1,050 | 2.10 | 1,350 | 2.70 | 3,310 | 6.62 | --- | --- | 1,640 | 3.28 | 5,560 | 5.56 | | |
| 12 | 600 | 6.0 | 900 | 1.80 | 1,300 | 2.60 | 920 | 1.84 | --- | --- | 740 | 1.48 | 4,850 | 4.85 | | |

1963

| | TRO C-2 | | TRO C-3 | | TRO C-1, 4, 5, 6 | | Canal diversions C-2 | | Canal diversions C-3 | | Canal diversions C-1,4-6 | | River inflow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | 1/100 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/500 Volts | Actual Value | 1/1000 Volts | Actual Value | Volts |
| 1 | 560 | 5.6 | 1,000 | 2.00 | 1,400 | 2.80 | 1,030 | 2.06 | --- | --- | 530 | 1.06 | 4,300 | 4.30 | | |
| 2 | 550 | 5.5 | 1,000 | 2.00 | 2,000 | 4.00 | 900 | 1.80 | --- | --- | 530 | 1.06 | 8,520 | 8.52 | | |
| 3 | 580 | 5.8 | 1,100 | 2.20 | 1,400 | 2.80 | 2,490 | 4.98 | --- | --- | 1,750 | 3.50 | 10,670 | 10.67 | | |
| 4 | 710 | 7.1 | 1,400 | 2.80 | 2,700 | 5.40 | 5,200 | 10.40 | 3,200 | 6.40 | 2,800 | 5.60 | 11,360 | 11.36 | | |
| 5 | 1,040 | 10.4 | 6,150 | 12.30 | 6,700 | 13.40 | 8,970 | 17.94 | 6,000 | 12.00 | 7,800 | 15.60 | 13,060 | 13.06 | | |
| 6 | 780 | 7.8 | 4,100 | 8.20 | 4,800 | 9.60 | 6,500 | 13.00 | 3,700 | 7.40 | 4,640 | 9.28 | 7,670 | 7.67 | | |
| 7 | 610 | 6.1 | 2,400 | 4.80 | 2,700 | 5.40 | 8,500 | 17.00 | 5,000 | 10.00 | 4,000 | 8.00 | 10,030 | 10.03 | | |
| 8 | 580 | 5.8 | 1,900 | 3.80 | 2,000 | 4.00 | 5,200 | 10.40 | 4,960 | 9.92 | 2,800 | 5.60 | 8,880 | 8.88 | | |
| 9 | 560 | 5.6 | 1,400 | 2.80 | 1,650 | 3.30 | 3,670 | 7.34 | 2,900 | 5.80 | 2,000 | 4.00 | 3,690 | 3.69 | | |
| 10 | 550 | 5.5 | 1,150 | 2.30 | 1,600 | 3.20 | 4,600 | 9.20 | 1,120 | 2.24 | 2,390 | 4.78 | 4,580 | 4.58 | | |
| 11 | 530 | 5.3 | 1,050 | 2.10 | 1,400 | 2.80 | 3,080 | 6.16 | --- | --- | 1,780 | 3.56 | 3,930 | 3.93 | | |
| 12 | 550 | 5.5 | 1,050 | 2.10 | 1,450 | 2.90 | 1,300 | 2.60 | --- | --- | 760 | 1.52 | 3,830 | 3.83 | | |

TABLE 17.--Sub-basin D cropland root-zone deficit or surplus as computed in analog model

| Watershed | Efficiency[a] | 1961 | 1962 | 1963 |
|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. |
| D-1 and 5 | 30 | -19,400 | -11,200 | -25,300 |
| | 36 | -17,600 | - 7,500 | -23,200 |
| | 40 | -15,700 | - 3,800 | -21,200 |
| | 50 | -12,000 | 0 | -13,500 |
| D-2 and 3 | 30 | + 2,000 | + 2,100 | + 1,100 |
| | 33 | + 2,200 | + 2,500 | + 1,400 |
| | 40 | + 2,900 | + 3,300 | + 1,900 |
| | 50 | + 3,700 | + 4,500 | + 2,800 |
| D-4 | 30 | - 6,100 | - 200 | - 9,600 |
| | 32 | - 5,500 | 0 | - 7,600 |
| | 40 | - 2,900 | + 1,800 | - 1,800 |
| | 50 | + 200 | + 6,000 | + 3,200 |

[a]Overall efficiency from diversion to root zone.

Note: Negative values are deficits; positive values are surpluses.

TABLE 18.--Sub-basin D change in cropland soil moisture storage

| Watershed | Efficiency | 1961 | 1962 | 1963 |
|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. |
| D-1 and 5 | 30 | +1,900 | -2,600 | + 400 |
| | 35 | +2,300 | -3,000 | + 300 |
| | 40 | +2,500 | -3,400 | + 200 |
| | 50 | +3,200 | - 500 | -3,500 |
| D-2 and 3 | 30 | 0 | 0 | 0 |
| | 33 | 0 | 0 | 0 |
| | 40 | 0 | 0 | 0 |
| | 50 | 0 | 0 | 0 |
| D-4 | 30 | + 900 | -1,300 | + 100 |
| | 32 | + 900 | - 600 | - 700 |
| | 40 | +1,200 | +2,100 | -4,100 |
| | 50 | +1,600 | +3,100 | -5,500 |

Note: Figures are the differences between the first-of-year and end-of-year storage.

TABLE 19.--Sub-basin D actual deficit - Root-zone supply minus potential consumptive use

| Watershed | Efficiency | 1961 | 1962 | 1963 |
|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. |
| D-1 and 5 | 30 | -17,500 | -13,800 | -24,900 |
| | 35 | -15,300 | -10,500 | -22,900 |
| | 40 | -13,200 | - 7,200 | -21,000 |
| | 50 | - 8,800 | - 500 | -17,000 |
| D-2 and 3 | 30 | + 2,000 | + 2,100 | + 1,100 |
| | 33 | + 2,200 | + 2,500 | + 1,400 |
| | 40 | + 2,900 | + 3,300 | + 1,900 |
| | 50 | + 3,700 | + 4,500 | + 2,800 |
| D-4 | 30 | - 5,200 | - 1,500 | - 9,500 |
| | 32 | - 4,600 | - 600 | - 8,300 |
| | 40 | - 1,700 | + 3,900 | - 5,900 |
| | 50 | + 1,800 | + 9,100 | - 2,300 |

Note: This table is a combination of Tables 6 and 7. Negative values are deficits; positive values are surpluses.

TABLE 20.--Sub-basin C cropland root-zone deficit or surplus as computed in analog model

| Watershed | Efficiency[a] | 1961 | 1962 | 1963 |
|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. |
| C-2 | 25 | -11,200 | - 7,100 | -18,100 |
| | 30 | - 9,100 | - 3,700 | -15,400 |
| | 40 | - 5,100 | + 1,800 | - 9,800 |
| | 50 | - 750 | + 5,000 | - 2,000 |
| C-3 | 25 | -16,100 | -10,000 | -20,800 |
| | 30 | -15,000 | - 6,800 | -19,100 |
| | 40 | -12,900 | - 1,200 | -15,400 |
| | 50 | -10,700 | + 2,100 | - 8,100 |
| C-1, 4, 5, and 6 | 25 | - 5,600 | - 2,000 | -10,500 |
| | 30 | - 4,400 | - 600 | - 9,600 |
| | 40 | - 1,600 | + 3,400 | - 4,500 |
| | 50 | + 500 | + 6,200 | + 400 |

[a]Overall efficiency from diversion to root zone.

Note: Negative values are deficits; positive values are surpluses.

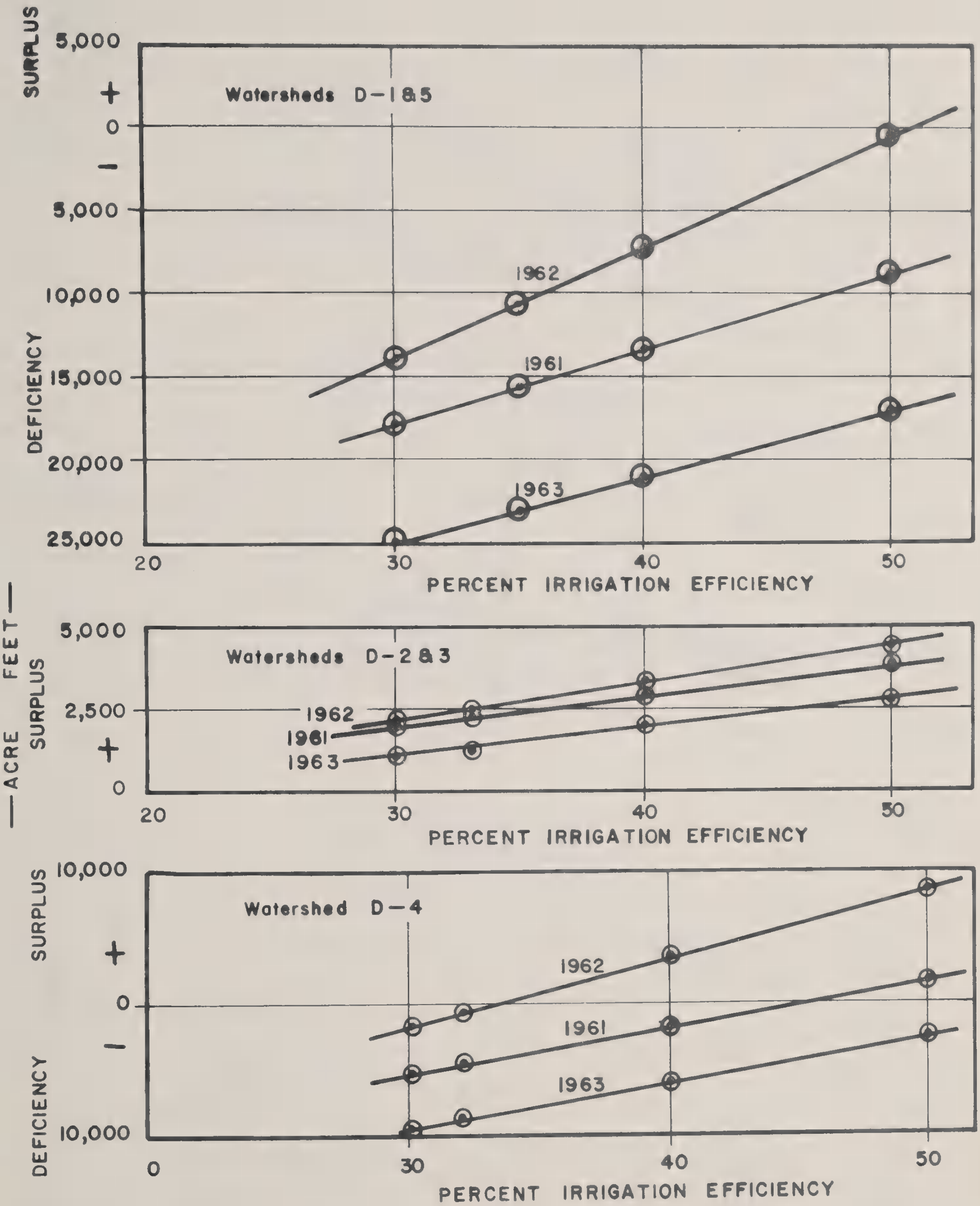
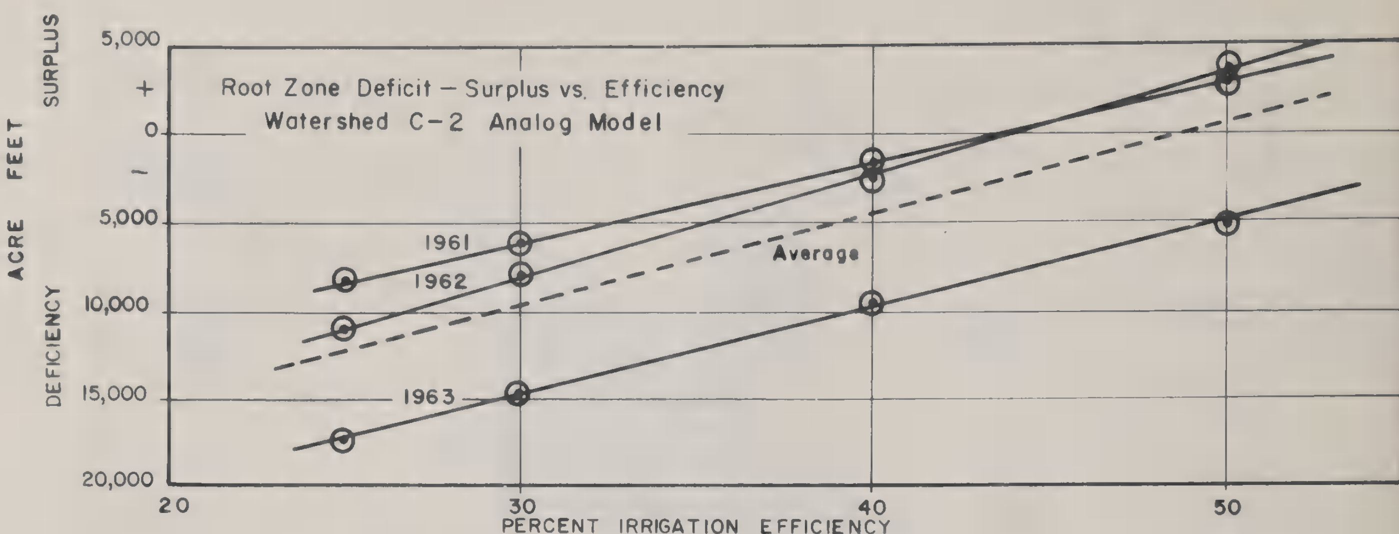



Figure 7

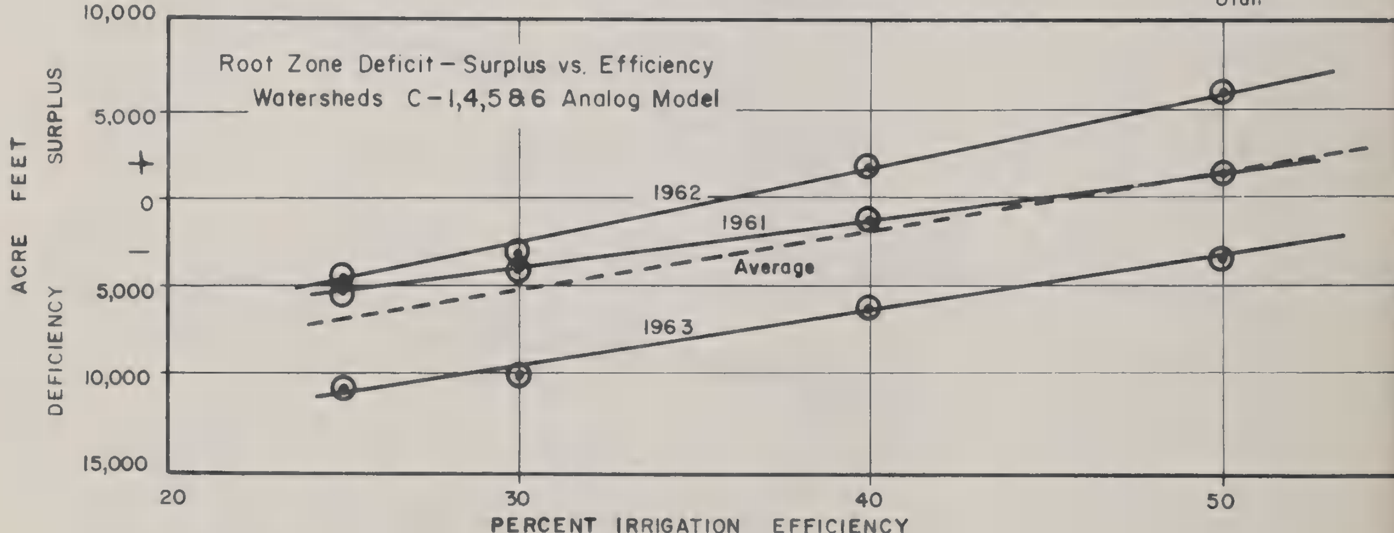
Root Zone Deficit - Surplus vs. Efficiency

**Watersheds D-1 thru 5 Analog Model**

Sevier River Basin
Utah




Utah



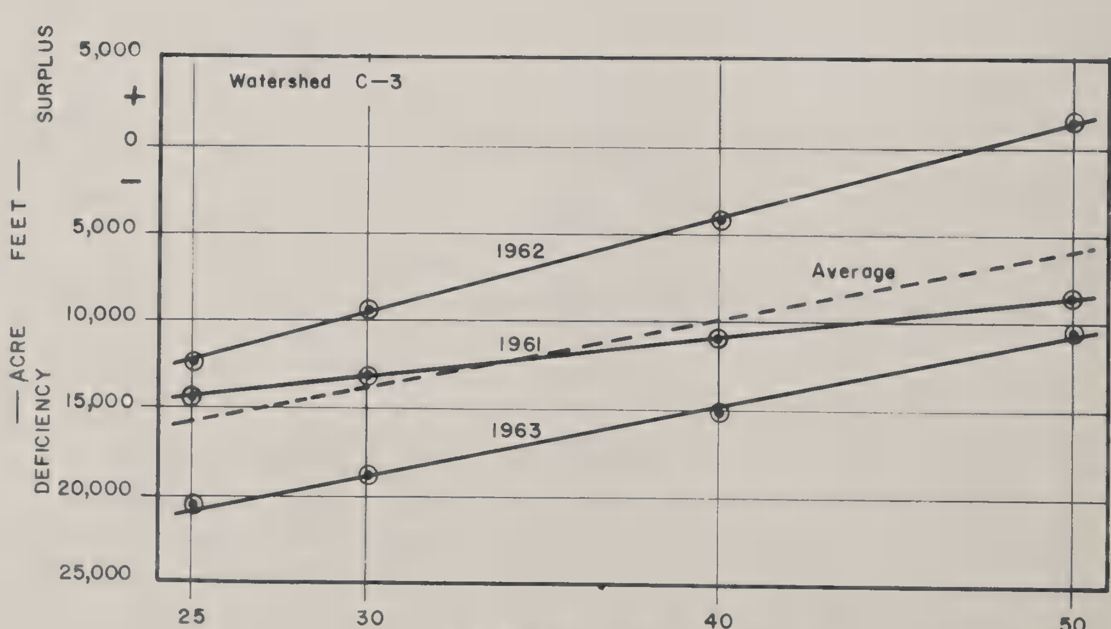




Figure 8
Root Zone Dificit — Surplus vs. Efficiency
Sub – Basin C Analog Model
Sevier River Basin
Utah

TABLE 21.--Sub-basin C change in cropland soil moisture storage

| Watershed | Efficiency[a] | 1961 | 1962 | 1963 |
|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. |
| C-2 | 25 | +2,600 | -4,000 | + 600 |
| | 30 | +2,800 | -4,400 | + 500 |
| | 40 | +3,300 | -4,400 | 0 |
| | 50 | +3,600 | -1,500 | -3,200 |
| C-3 | 25 | +1,800 | -2,300 | + 100 |
| | 30 | +1,900 | -2,600 | + 150 |
| | 40 | +2,000 | -2,900 | + 250 |
| | 50 | +2,300 | - 700 | -2,300 |
| C-1, 4, 5, and 6 | 25 | +1,000 | -1,800 | + 300 |
| | 30 | +1,100 | -2,000 | + 300 |
| | 40 | +1,200 | - 800 | -1,100 |
| | 50 | +1,700 | + 700 | -3,000 |

[a]Overall efficiency from diversion to root zone.

Note: Figures are the differences between the first-of-year and end-of-year storage.

TABLE 22.--Sub-basin C actual deficit - Root-zone supply minus potential consumptive use

| Watershed | Efficiency[a] | 1961 | 1962 | 1963 |
|---|---|---|---|---|
| | Percent | Ac. ft. | Ac. ft. | Ac. ft. |
| C-2 | 25 | - 8,600 | -11,100 | -17,500 |
| | 30 | - 6,300 | - 8,100 | -14,900 |
| | 40 | - 1,800 | - 2,600 | - 9,800 |
| | 50 | + 2,850 | + 3,500 | - 5,200 |
| C-3 | 25 | -14,300 | -12,300 | -20,700 |
| | 30 | -13,100 | - 9,400 | -18,950 |
| | 40 | -10,900 | - 4,100 | -15,150 |
| | 50 | - 8,400 | + 1,400 | -10,400 |
| C-1, 4, 5, and 6 | 25 | - 4,600 | - 3,800 | -10,200 |
| | 30 | - 3,300 | - 2,600 | - 9,300 |
| | 40 | - 400 | + 2,600 | - 5,600 |
| | 50 | + 2,200 | + 6,900 | - 2,600 |

[a]Overall efficiency from diversion to root zone.

Note: This table is a combination of Tables 6 and 7. Negative values are deficits; positive values are surpluses.

Project downstream effects in the Sub-basins D and C models were not reliable due to the groundwater reservoir circuits inability to reduct wetland consumptive use when the water tables were lowered. The downstream effects for projects in these two sub-basins were obtained in the combined Sub-basins A, C and D analog model described in Chapter VI.

# CHAPTER V

## SUB-BASIN B ANALOG MODEL

### DESCRIPTION OF THE MODEL

The analog model for Sub-basin B included only the water budget areas of Watersheds B-5, B-6 and B-7. Adequate basic data was not available in Watersheds B-1, B-2, B-3 and B-4 to program models for these areas. The three watersheds programmed contain about 200,000 acres of the 230,000 acres of water budget area in Sub-basin B, and thus the major portion of the water budget area was included in the model.

The first study area, Watersheds B-5 and B-6, have similar irrigation water supply patterns. These consist of a combination of water regulated by reservoir storage, diversions from tributary runoff, and water pumped from the groundwater reservoir. Watershed B-7, with essentially the entire irrigation water supply regulated by reservoir storage, constituted the second study area. The total tributary runoff for Watersheds B-5 and B-6 was divided between surface runoff and groundwater according to the average annual water budgets during calibration of the model. The surface and groundwater outflow from Watersheds B-5 and B-6 are inflow into Watershed B-7. For Watershed B-7, all the tributary runoff enters as groundwater.

Equipment limitations required that the same monthly distribution of temperature and precipitation be used for both model segments. The temperature and precipitation for the average of Watersheds B-5 and B-6 were set on the input potentiometers (since B-5 and B-6 had the higher numerical values) and these voltages were adjusted by means of a potentiometer to represent the data for Watershed B-7. In each of the two model segments, a weighted vegetation growth stage coefficient ($k_c$) was obtained for the cropland area and for the wetland area.

The hydrologic factors which change each month are described below and the corresponding data are shown in Tables 23a and 23b.

1. Canal diversions to the cropland, in acre-feet.
2. Irrigation water pumped from wells, in acre-feet.
3. Tributary runoff, in acre-feet.
4. River inflow, in acre-feet.
5. Precipitation, in inches.

TABLE 23a.--Hydrologic factors whose values vary monthly - Average annual water supply conditions

| | B-5 & 6 Canal Diversions | | B-5 & 6 Pumping | | B-5 & 6 TRO[a] | | B-7 Canal Diversions | | B-7 Pumping | | B-7 TRO[a] | | B-5 River Inflow | | B-5 & 6 Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | --- | --- | --- | | 2,700 | 5.40 | 300 | 0.3 | --- | | 120 | .60 | 1,440 | 1.44 | 1.05 | 10.5 |
| 2 | --- | --- | --- | | 2,750 | 5.50 | 590 | .59 | --- | | 110 | .55 | 1,750 | 1.75 | 1.14 | 11.4 |
| 3 | 1,570 | 3.14 | 50 | .25 | 3,490 | 6.98 | 1,730 | 1.73 | --- | | 110 | .55 | 4,940 | 4.94 | 1.29 | 12.9 |
| 4 | 5,430 | 10.86 | 980 | 4.90 | 7,510 | 15.02 | 9,340 | 9.34 | --- | | 120 | .60 | 12,470 | 12.47 | 1.17 | 11.7 |
| 5 | 17,150 | 34.30 | 1,100 | 5.50 | 14,060 | 28.12 | 31,190 | 31.19 | 180 | .90 | 180 | .90 | 40,180 | 40.18 | 1.06 | 10.6 |
| 6 | 9,050 | 18.10 | 1,190 | 5.95 | 6,490 | 12.98 | 20,720 | 20.72 | 360 | 1.80 | 190 | .95 | 26,960 | 26.96 | .63 | 6.3 |
| 7 | 8,450 | 16.90 | 1,250 | 6.25 | 2,670 | 5.34 | 22,600 | 22.60 | 370 | 1.85 | 180 | .90 | 31,680 | 31.68 | .50 | 5.0 |
| 8 | 5,380 | 10.76 | 1,175 | 5.88 | 1,950 | 3.90 | 15,640 | 15.64 | 370 | 1.85 | 170 | .85 | 20,030 | 20.03 | .75 | 7.5 |
| 9 | 4,010 | 8.02 | 1,065 | 5.32 | 1,540 | 3.08 | 7,330 | 7.33 | 180 | .90 | 150 | .75 | 11,880 | 11.88 | .48 | 4.8 |
| 10 | 1,290 | 2.58 | 430 | 2.15 | 2,070 | 4.14 | 3,700 | 3.70 | --- | | 150 | .75 | 4,830 | 4.83 | .94 | 9.4 |
| 11 | 230 | .46 | 50 | .25 | 2,190 | 4.38 | 5,480 | 5.48 | --- | | 130 | .65 | 3,800 | 4.80 | .93 | 9.3 |
| 12 | --- | --- | --- | | 2,640 | 5.28 | 1,020 | 1.07 | --- | | 130 | .65 | 2,020 | 2.02 | .97 | 9.7 |

| | Percent Daytime Hours | | | | Watersheds B-5 & 6 Cropland $k_c$ | | Watersheds B-5 & 6 Wetland $k_c$ | | Watershed B-7 Cropland $k_c$ | | Watershed B-7 Wetland $k_c$ | | B-5 & 6 Temperature | | B-7 Use from Groundwater | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 6.78 | 20.54 | | | .54 | 13.50 | .56 | 14.00 | .49 | 12.25 | 0.35 | 8.75 | 28.9 | 14.45 | 190 | .95 |
| 2 | 6.75 | 20.45 | | | .61 | 15.25 | .60 | 15.00 | .55 | 13.75 | .36 | 9.00 | 33.6 | 16.80 | 290 | 1.45 |
| 3 | 8.32 | 25.21 | | | .68 | 17.00 | .64 | 16.00 | .61 | 15.25 | .38 | 9.50 | 41.4 | 20.70 | 600 | 3.00 |
| 4 | 8.91 | 27.00 | | | .75 | 18.75 | .65 | 16.25 | .66 | 16.50 | .39 | 9.75 | 50.6 | 25.30 | 1,250 | 6.25 |
| 5 | 9.97 | 30.21 | | | 1.00 | 25.00 | .68 | 17.00 | .88 | 22.00 | .41 | 10.25 | 59.2 | 29.60 | 2,410 | 12.05 |
| 6 | 10.04 | 30.42 | | | 1.21 | 30.25 | .74 | 18.50 | 1.15 | 28.75 | .48 | 12.00 | 68.6 | 34.30 | 5,270 | 26.35 |
| 7 | 10.25 | 31.06 | | | 1.02 | 25.50 | .77 | 19.25 | .97 | 24.25 | .52 | 13.00 | 77.5 | 38.75 | 6,950 | 34.75 |
| 8 | 9.53 | 28.88 | | | .87 | 21.75 | .82 | 20.50 | .72 | 18.00 | .57 | 14.25 | 75.8 | 37.90 | 3,790 | 18.95 |
| 9 | 8.40 | 25.45 | | | .78 | 19.50 | .85 | 21.25 | .42 | 10.50 | .58 | 14.50 | 67.0 | 33.50 | 1,200 | 6.00 |
| 10 | 7.79 | 23.60 | | | .70 | 17.50 | .83 | 20.75 | .35 | 8.75 | .56 | 14.00 | 54.8 | 27.40 | 540 | 2.70 |
| 11 | 6.77 | 20.51 | | | .63 | 15.75 | .89 | 22.25 | .47 | 11.75 | .55 | 13.75 | 39.6 | 19.80 | 270 | 1.35 |
| 12 | 6.58 | 19.94 | | | .55 | 13.75 | .65 | 16.25 | .50 | 12.50 | .43 | 10.75 | 32.2 | 16.10 | 230 | 1.15 |

[a] TRO=Tributary Runoff

TABLE 23b.--Hydrologic factors whose values vary monthly - 20% and 80% chance water supply conditions, 20% chance water supply

| | B-5 & 6 Canal Diversions | | B-5 & 6 Pumping | | B-5 & 6 TRO[a] | | B-7 Canal Diversions | | B-7 Pumping | | B-7 TRO[a] | | B-5 River Inflow | | B-5 & 6 Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 0 | | 0 | --- | 3,970 | 7.94 | 327 | .33 | --- | | 170 | .85 | 1,742 | 1.74 | 1.42 | 14.2 |
| 2 | 0 | | 0 | --- | 4,120 | 8.24 | 700 | .70 | --- | | 170 | .85 | 2,119 | 2.12 | 1.52 | 15.2 |
| 3 | 1,929 | 3.86 | 50 | .25 | 5,280 | 10.56 | 1,973 | 1.97 | --- | | 160 | .80 | 6,000 | 6.00 | 1.76 | 17.6 |
| 4 | 8,411 | 16.82 | 980 | 4.90 | 11,100 | 22.20 | 10,331 | 10.33 | --- | | 170 | .85 | 15,147 | 15.15 | 1.59 | 15.9 |
| 5 | 23,733 | 47.47 | 1,100 | 5.50 | 20,460 | 40.92 | 34,660 | 34.66 | 180 | 0.90 | 270 | 1.35 | 48,807 | 48.81 | 1.44 | 14.4 |
| 6 | 13,351 | 26.70 | 1,190 | 5.95 | 9,210 | 18.42 | 23,080 | 23.08 | 360 | 1.8 | 270 | 1.35 | 32,749 | 32.75 | .86 | 8.6 |
| 7 | 11,577 | 23.15 | 1,250 | 6.25 | 3,790 | 7.58 | 25,191 | 25.19 | 370 | 1.85 | 260 | 1.30 | 38,491 | 38.49 | .68 | 6.8 |
| 8 | 7,738 | 15.47 | 1,175 | 5.88 | 2,770 | 5.54 | 17,402 | 17.40 | 370 | 1.85 | 240 | 1.20 | 24,334 | 24.33 | 1.02 | 10.2 |
| 9 | 5,875 | 11.75 | 1,065 | 5.32 | 2,190 | 4.38 | 8,143 | 8.14 | 180 | 0.90 | 220 | 1.10 | 14,434 | 14.43 | .65 | 6.5 |
| 10 | 2,022 | 4.04 | 430 | 2.15 | 3,090 | 6.18 | 4,111 | 4.11 | --- | | 200 | 1.00 | 5,881 | 5.88 | 1.28 | 12.8 |
| 11 | 247 | .49 | 50 | .25 | 3,330 | 6.66 | 6,118 | 6.12 | --- | | 190 | .95 | 5,841 | 5.84 | 1.27 | 12.7 |
| 12 | 0 | | 0 | --- | 3,780 | 7.56 | 1,151 | 1.15 | --- | | 180 | .90 | 2,455 | 2.46 | 1.30 | 13.0 |

80% Chance Water Supply

| | B-5 & 6 Canal Diversions | | B-5 & 6 Pumping | | B-5 & 6 TRO[a] | | B-7 Canal Diversions | | B-7 Pumping | | B-7 TRO[a] | | B-5 River Inflow | | B-5 & 6 Precipitation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | --- | | --- | | 1,990 | 3.98 | 262 | .26 | --- | | 80 | .40 | 1,118 | 1.12 | 0.78 | 7.8 |
| 2 | --- | | --- | | 2,040 | 4.08 | 564 | .56 | --- | | 80 | .40 | 1,359 | 1.36 | .84 | 8.4 |
| 3 | 1,466 | 2.93 | 50 | .25 | 2,370 | 4.74 | 1,548 | 1.55 | --- | | 80 | .40 | 3,848 | 3.85 | .89 | 8.9 |
| 4 | 4,278 | 8.56 | 980 | 4.90 | 5,010 | 10.02 | 8,280 | 8.28 | --- | | 80 | .40 | 9,716 | 9.72 | .81 | 8.1 |
| 5 | 12,717 | 25.43 | 1,100 | 5.50 | 9,800 | 19.60 | 27,784 | 27.78 | 180 | 0.90 | 130 | .65 | 31,305 | 31.30 | .74 | 7.4 |
| 6 | 6,828 | 13.66 | 1,190 | 5.95 | 4,530 | 9.06 | 18,500 | 18.50 | 360 | 1.80 | 130 | .65 | 21,006 | 21.01 | .44 | 4.4 |
| 7 | 5,781 | 11.56 | 1,250 | 6.25 | 1,860 | 3.72 | 20,193 | 20.19 | 370 | 1.85 | 130 | .65 | 24,689 | 24.69 | .35 | 3.5 |
| 8 | 3,741 | 7.48 | 1,175 | 5.88 | 1,360 | 2.72 | 13,949 | 13.95 | 370 | 1.85 | 120 | .60 | 15,608 | 15.61 | .52 | 5.2 |
| 9 | 2,648 | 5.30 | 1,065 | 5.32 | 1,080 | 2.16 | 6,525 | 6.53 | 180 | .90 | 110 | .55 | 9,258 | 9.26 | .33 | 3.3 |
| 10 | 1,158 | 2.32 | 430 | 2.15 | 1,140 | 2.28 | 3,297 | 3.30 | --- | | 100 | .50 | 3,772 | 3.77 | .65 | 6.5 |
| 11 | 420 | .84 | 50 | .25 | 1,390 | 2.78 | 4,904 | 4.90 | --- | | 90 | .45 | 3,746 | 3.75 | .64 | 6.4 |
| 12 | 0 | | --- | | 1,890 | 3.78 | 922 | .92 | --- | | 90 | .45 | 1,575 | 1.58 | .72 | 7.2 |

[a] TRO=Tributary Runoff

6. Percent daytime hours.
7. Weighted vegetation growth stage coefficients for the cropland and wetlands.
8. Temperature, in $^{O}$ F.
9. Direct use from groundwater by crops in Watershed B-7, in acre-feet.

The items in the botton half of Table 23a were used for all irrigation water supply conditions investigated; average annual, 20 percent and 80 percent chance. The items in the top half of Table 23a changed for each irrigation water supply condition. These values for the 20 percent and 80 percent chance supply conditions are shown in Table 23b.

Irrigation efficiencies used for calibration of the Watershed B-7 model were taken from the average annual water budget; 45 percent for canal and 50 percent for well diversions. The irrigation efficiencies for Watersheds B-5 and B-6 were weighted from the individual average annual water budgets. The resulting efficiencies were 22.4 percent for canal and 40 percent for well diversions.

The groundwater storage circuit developed for the Sub-basin D analog model, was used for this sub-basin. This made it possible to observe the monthly change in groundwater storage and groundwater flow to the river. (Figures 9 through 14).

The hydrologic factors which do not change during the year are shown in the following table:

TABLE 24.--Hydrologic factors of constant value for the entire year

| Hydrologic factor | Watershed | Unit | Value |
|---|---|---|---|
| Cropland area | B-5 and 6 | acres | 12,530 |
| | B-7 | acres | 61,630 |
| Wetland area | B-5 and 6 | acres | 12,800 |
| | B-7 | acres | 109,120 |
| Canal water irrigation efficiency | B-5 and 6 | percent | 22.4 |
| | B-7 | percent | 45 |
| Pumped water irrigation efficiency | B-5 and 6 | percent | 40 |
| | B-7 | | 50 |
| Root zone moisture holding capacity | B-5 and 6 | inches | 10.58 |
| | B-7 | inches | 10.12 |
| Tributary runoff, surface | B-5 and 6 | percent | 41.0 |
| Tributary runoff, groundwater | B-5 and 6 | percent | 59.0 |
| Temperature adjustment | B-5 and 6 to B-7 | percent | 94.0 |
| Precipitation adjustment | B-5 and 6 to B-7 | percent | 60.0 |

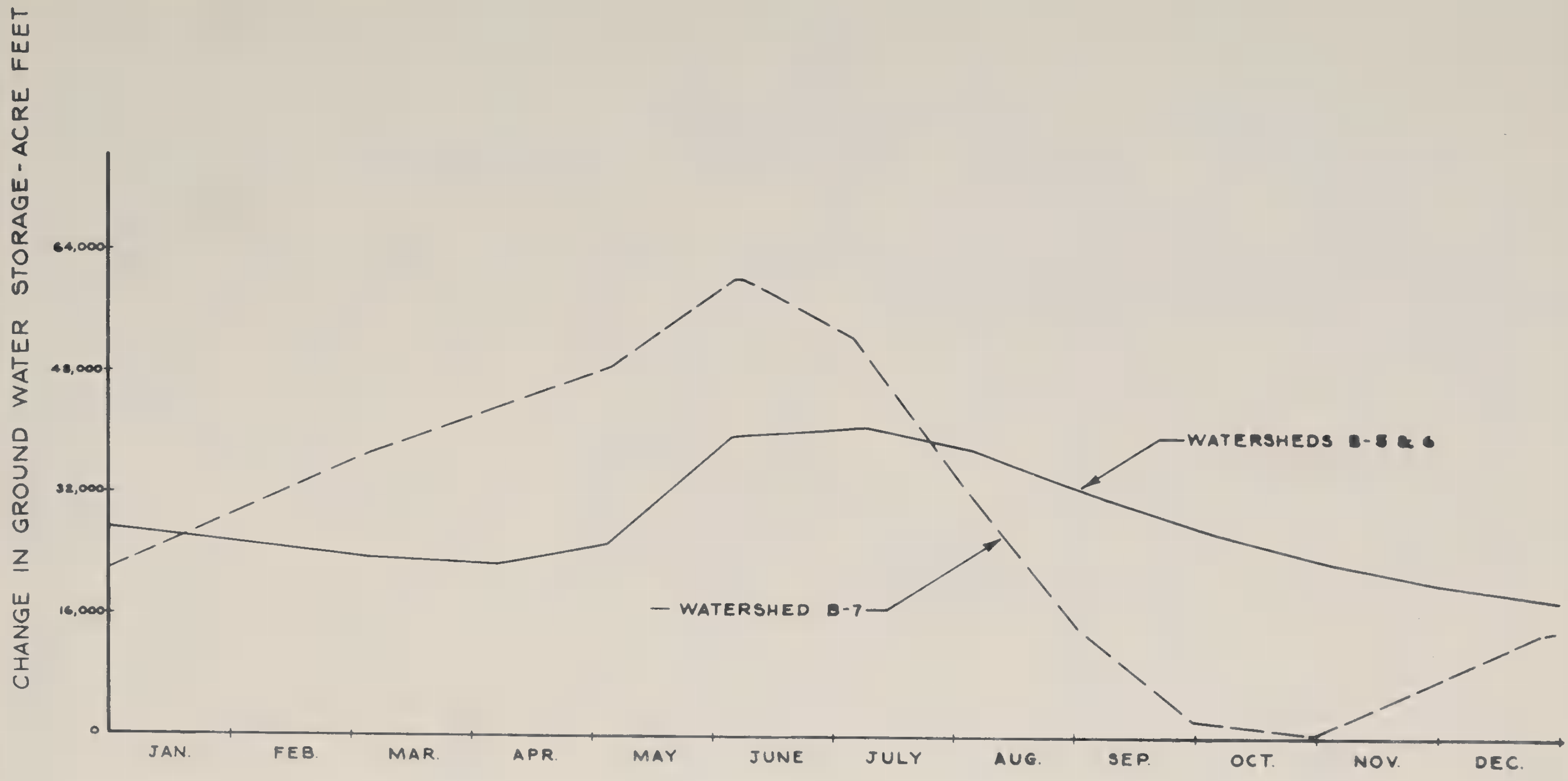



FIGURE: 9 SUB-BASIN B ANALOG MODEL - GROUND WATER STORAGE

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN

UTAH

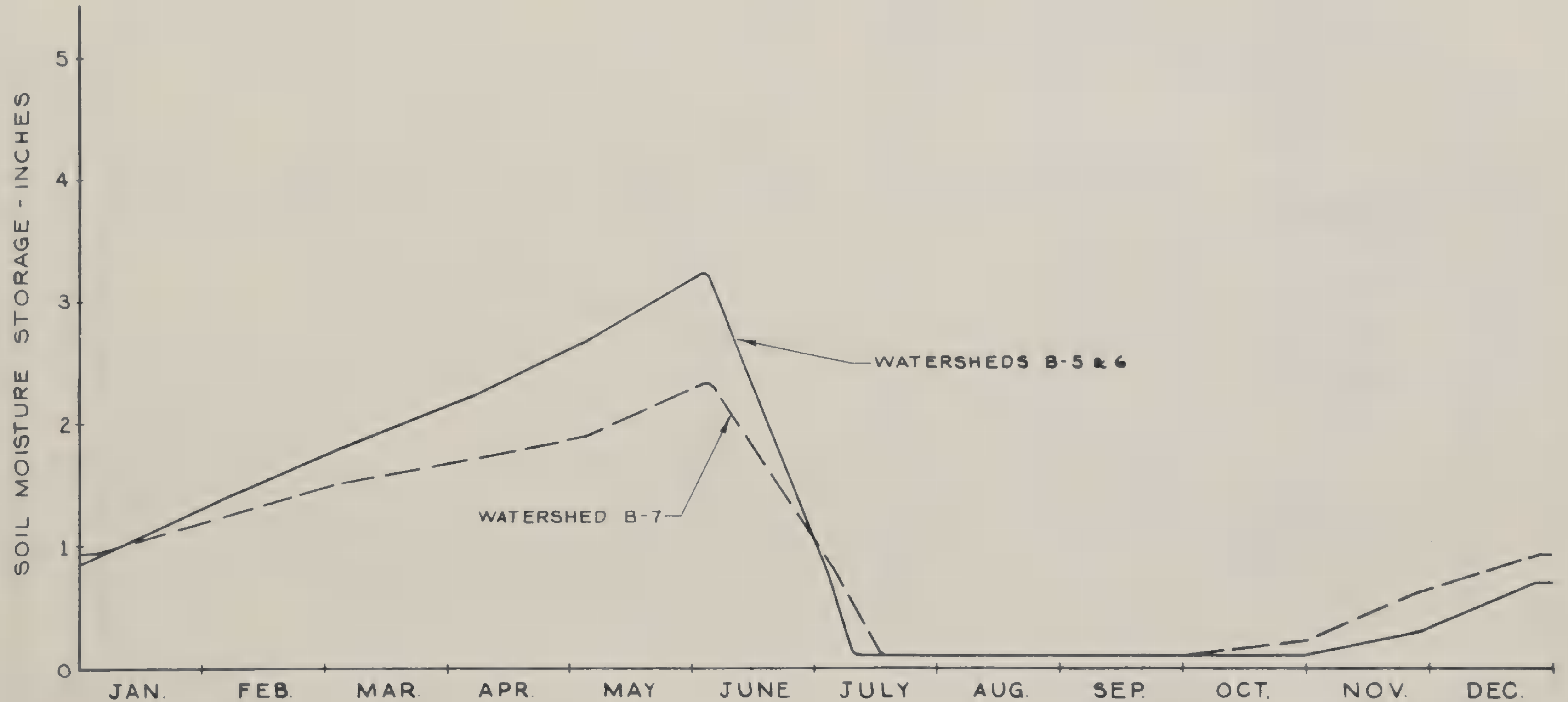



FIGURE: 10 SUB-BASIN B ANALOG MODEL - SOIL MOISTURE STORAGE

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN
UTAH

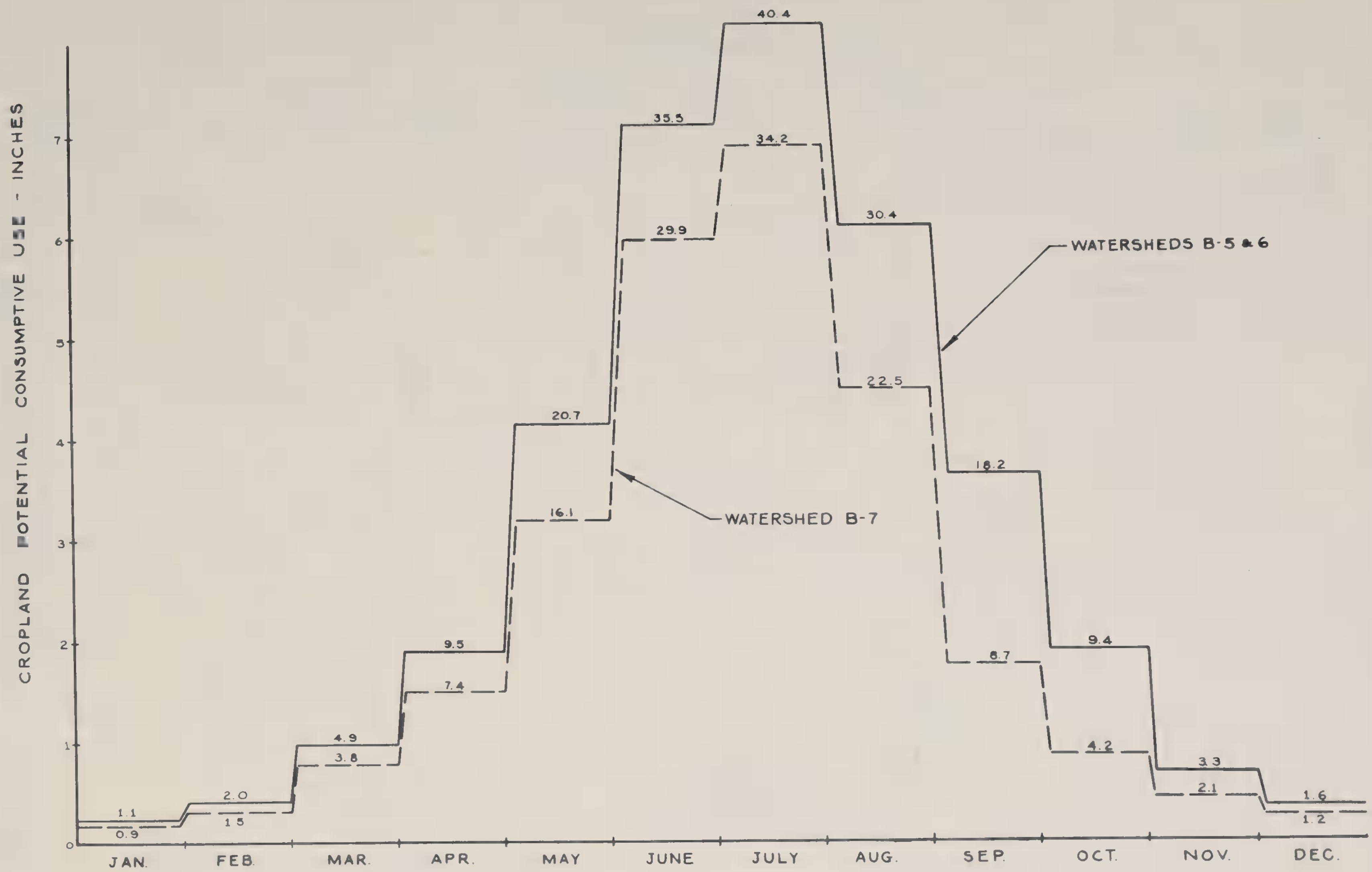



FIGURE: II SUB-BASIN B ANALOG MODEL - CROPLAND POTENTIAL CONSUMPTIVE USE

AVERAGE ANNUAL WATER SUPPLY
SEVIER RIVER BASIN
UTAH

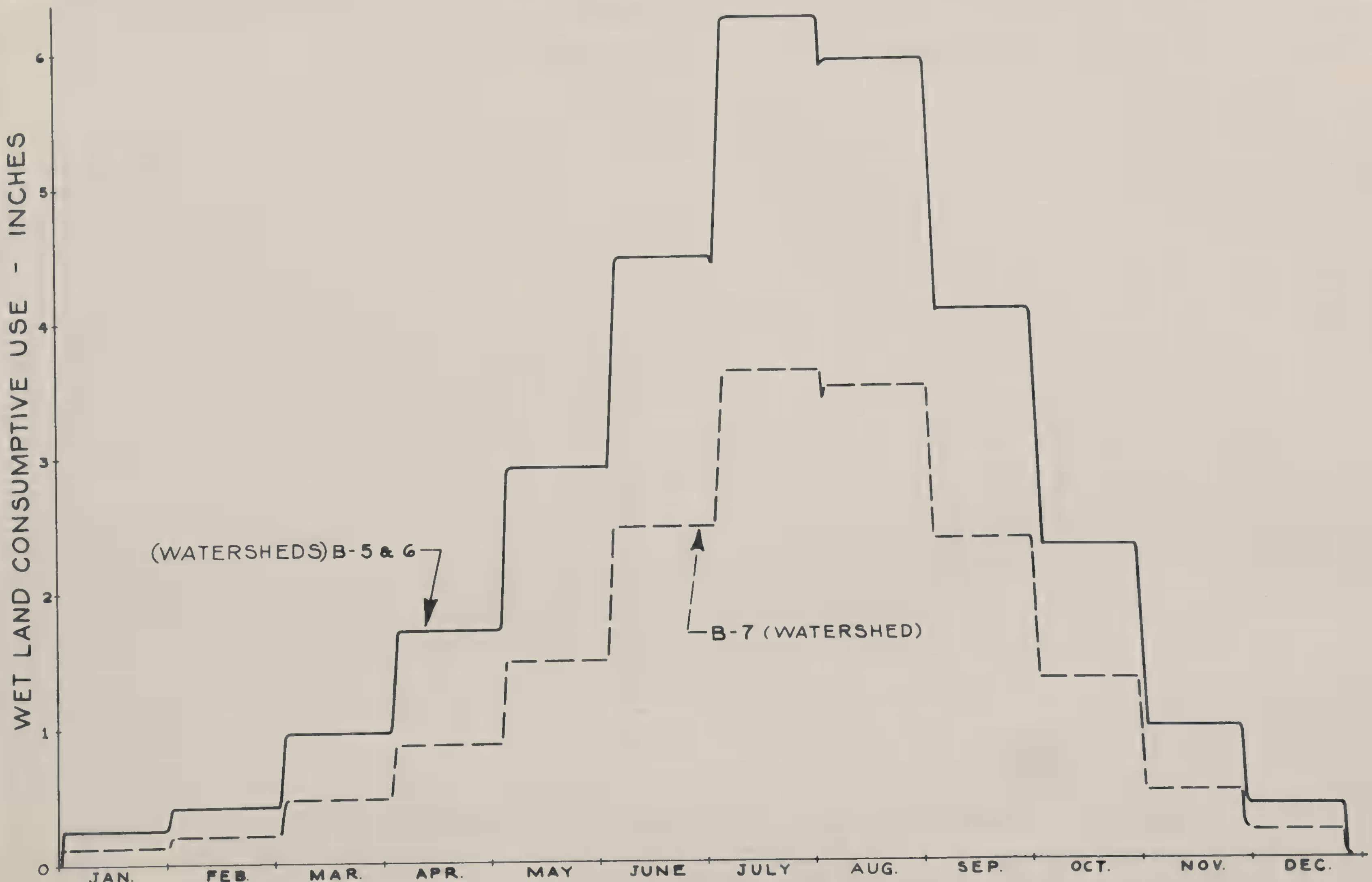



FIGURE: 12 SUB-BASIN B ANALOG MODEL - WET LAND CONSUMPTIVE USE

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN
UTAH

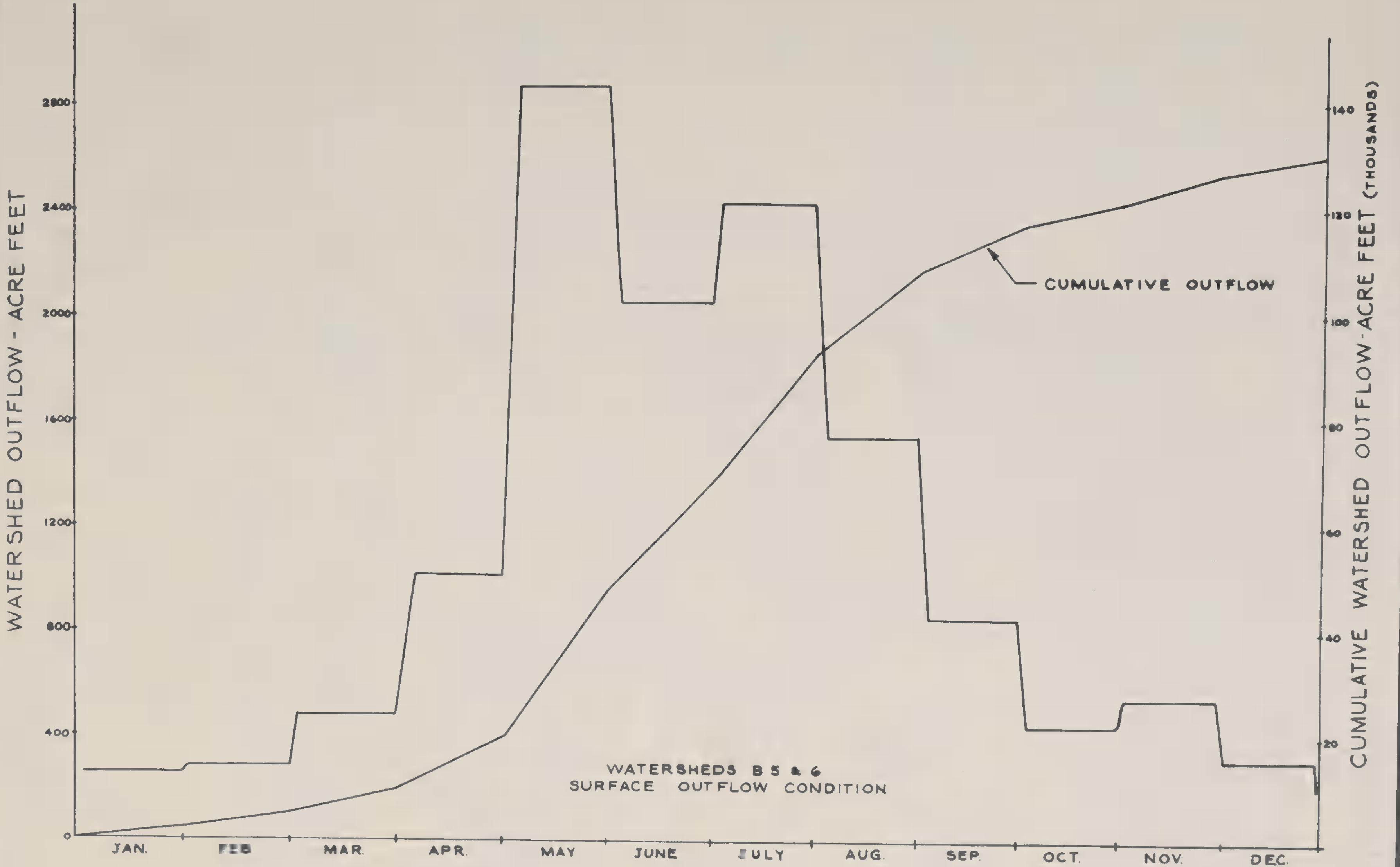



FIGURE: 13 SUB-BASIN B ANALOG MODEL - WATERSHED OUTFLOW (CUMULATIVE & MONTHLY)
AVERAGE ANNUAL WATER SUPPLY
SEVIER RIVER BASIN
UTAH

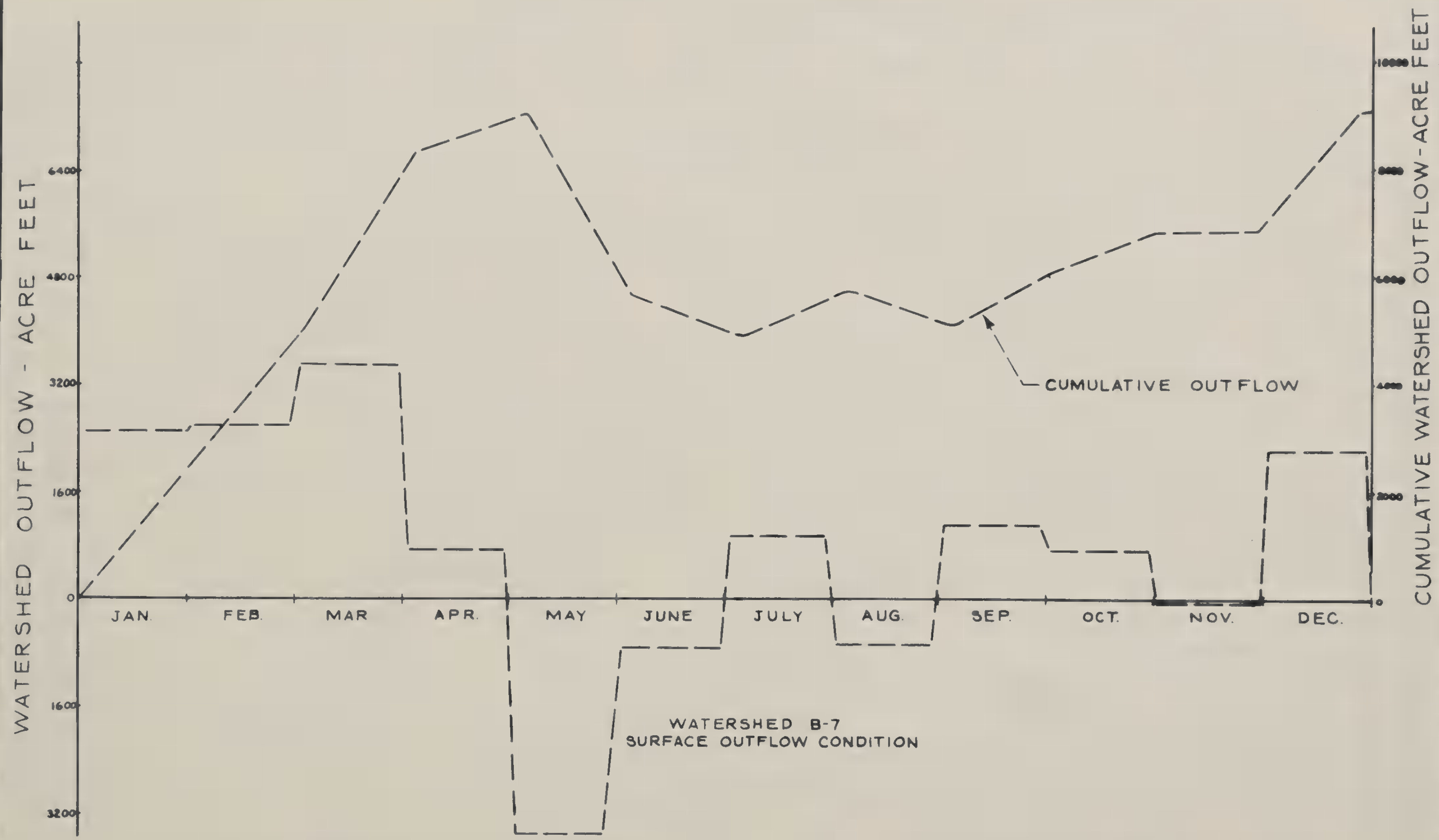



FIGURE: 14 SUB-BASIN B ANALOG MODEL - WATERSHED OUTFLOW(CUMULATIVE & MONTHLY)

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN
UTAH

## CONDITIONS INVESTIGATED

In Sub-basin B, the model was calibrated using data from the average annual water budgets. In order to study the effects of various levels of water supply, an 80 percent chance and 20 percent chance water supply were programmed to represent a dry and wet year, respectively. Precipitation, streamflow, canal diversions, and tributary runoff were varied to reflect these water supply levels. Canal diversion records were used to determine the quantities diverted, the Oak City and Deseret Weather Bureau climatological stations were used to adjust precipitation, the Chalk Creek streamflow record was used to adjust tributary runoff, and the Juab River gage was used to adjust river inflow.

To allow for additional variability of water supply, various combinations of the wet, dry, and average water supply years were programmed. In all nine cases, the initial conditions for the year preceding those studied were for an average water supply year. The nine combinations used are as follows:

(1) Average year following an average year
(2) Average year following a dry year
(3) Average year following a wet year
(4) Dry year following an average year
(5) Dry year following a dry year
(6) Dry year following a wet year
(7) Wet year following an average year
(8) Wet year following a dry year
(9) Wet year following a wet year

Several levels of irrigation efficiency were superimposed on each combination. In Watersheds B-5 and 6, the present efficiency of 22.4 percent and efficiencies of 30 percent, 40 percent and 50 percent were programmed. The present efficiency of 45 percent and efficiencies of 50 percent and 55 percent were programmed for Watershed B-7.

A pumping project was superimposed on the first, fourth and seventh combinations to investigate the effects of increasing the irrigation water supply. Under project conditions, only enough water was pumped to overcome the deficit and then the resulting effects on groundwater storage, soil moisture storage, and outflow were plotted. Table 25 shows the increase from average quantities pumped for each irrigation efficiency.

TABLE 25.--Increase from average conditions in irrigation water pumped from wells

| Irrigation efficiency[a] | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| WATERSHEDS B-5 and B-6 | | | | | | |
| Average water supply | | | | | | |
| 22.4 percent[a] | 900 | 3,800 | 4,200 | 4,200 | 1,300 | 14,400 |
| 40 percent | 0 | 600 | 1,200 | 1,200 | 500 | 3,500 |
| 50 percent | | No additional pumping required | | | | |
| 80 percent chance supply | | | | | | |
| 22.4 percent | 3,500 | 8,000 | 8,000 | 8,000 | 3,300 | 30,800 |
| 40 percent | 1,900 | 4,600 | 4,800 | 4,600 | 1,700 | 17,600 |
| 50 percent | 0 | 1,400 | 1,400 | 1,400 | 100 | 4,300 |
| 20 percent chance supply | | | | | | |
| 22.4 percent | 300 | 1,600 | 1,600 | 1,600 | 100 | 5,200 |
| WATERSHED B-7 | | | | | | |
| Average water supply | | | | | | |
| 45 percent[b] | 9,800 | 9,700 | 9,600 | 9,600 | 5,000 | 43,700 |
| 50 percent | 3,800 | 6,700 | 7,600 | 7,600 | 3,800 | 29,500 |
| 55 percent | 2,400 | 4,700 | 4,600 | 4,600 | 2,400 | 18,700 |
| 80 percent chance supply | | | | | | |
| 45 percent | 10,500 | 10,500 | 10,500 | 10,500 | 4,900 | 46,900 |
| 50 percent | 6,200 | 9,700 | 9,600 | 9,600 | 3,800 | 39,800 |
| 55 percent | 3,600 | 7,300 | 7,400 | 7,400 | 2,800 | 28,500 |
| 20 percent chance supply | | | | | | |
| 45 percent | 800 | 1,700 | 1,800 | 1,800 | 800 | 6,900 |

[a] Pumped water irrigation efficiency of 50 percent under all conditions.

[b] Pumped water irrigation efficiency of 55 percent under all conditions.

## SUMMARY OF RESULTS

To calibrate the Sub-basin B analog model, it was necessary to reduce the wetland vegetative growth stage coefficients ($k_c$) in Watershed B-7 by 25 percent. This adjustment was necessary to make the outflow correspond with the predetermined outflow values. The $k_c$ values are shown in Table 23a.

Calibration of the groundwater reservoir circuits indicated that a 10,000 acre-foot change in groundwater storage would produce the following change in natural flows from the groundwater reservoirs:

Watersheds B-5 and 6: 400 acre-feet per month
Watershed B-7: 40 acre-feet per month

Because more exact information was not available, these relationships were considered linear within the range of groundwater fluctuations encountered. The two relationships indicate the differences in areal extent and hydrologic characteristics of the groundwater reservoirs.

To balance the model, it was necessary to make 95 percent of the surface water outflow from Watersheds B-5 and 6 available for diversion in Watershed B-7. The remaining 5 percent was routed to the groundwater and wetland area circuits of Watershed B-7. This 5 percent simulated the transpiration, evaporation, and seepage losses between the river gage near Lynndyl and the points of diversion in Watershed B-7.

Tables 26 to 29 summarize the measurable effects of the possible project conditions outlined above. The deficit and surplus figures shown in Table 26 are based on no net change in soil moisture storage during the year.

TABLE 26.-Cropland root zone deficit-Supply minus potential consumptive use

| Watershed | Irrigation efficiency | 80% chance water supply | Average annual water supply | 20% chance water supply |
|---|---|---|---|---|
| B-5&6 | 22.4% | -17,200 | -10,900 | - 1,850 |
| | 30% | -14,300 | - 6,900 | + 3,850 |
| | 40% | -10,400 | - 1,650 | +11,400 |
| | 50% | - 6,450 | + 3,650 | +18,800 |
| B-7 | 40% | -44,900 | -30,100 | -13,000 |
| | 45% | -39,500 | -24,100 | - 6,400 |
| | 50% | -34,200 | -18,200 | + 300 |
| | 55% | -28,900 | -12,200 | + 6,900 |

Note: Negative values are deficits; positive values are surpluses

TABLE 27.-Change in groundwater storage due to natural changes in water supply conditions

| Water supply condition | Watersheds B-5 & 6 | Watershed B-7 |
|---|---|---|
| | Acre-feet | Acre-feet |
| Average supply year following average | 0 | 0 |
| Average supply year following dry | + 6,400 | - 5,600 |
| Average supply year following wet | - 9,600 | + 5,200 |
| 80% chance supply year following average | -18,400 | -32,400 |
| 80% chance supply year following dry | -11,600 | -34,800 |
| 80% chance supply year following wet | | |
| 20% chance supply year following average | +26,400 | -34,400 |
| 20% chance supply year following dry | +34,000 | +31,200 |
| 20% chance supply year following wet | +17,200 | +41,200 |

Note: Changes are measured from beginning to end of year

TABLE 28a.--Change in groundwater storage due to changing irrigation efficiency, Watersheds B-5 and B-6

| Water supply condition | Cropland irrigation efficiency 22.4% | 30% | 40% | 50% |
|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| Average supply following average | 0 | -2,400 | -6,800 | -10,400 |
| Average supply following dry | 0 | -5,200 | -13,200 | -20,800 |
| Average supply following wet | 0 | -6,400 | -11,200 | -13,600 |
| 80 percent chance supply following average | 0 | -3,200 | -9,600 | -14,800 |
| 80 percent chance supply following dry | 0 | -4,400 | -11,200 | -17,200 |
| 80 percent chance supply following wet | 0 | -5,200 | -11,600 | -13,200 |
| 20 percent chance supply following average | 0 | -5,200 | -11,200 | -14,800 |
| 20 percent chance supply following dry | 0 | -6,400 | -13,600 | -19,200 |
| 20 percent chance supply following wet | 0 | -4,800 | -9,200 | -11,600 |
| Pumping Projects | | | | |
| Average supply following average | -9,600 | - | -9,600 | --[a] |
| 80 percent chance supply following average | -18,800 | - | -18,800 | -16,400 |
| 20 percent chance supply following average | -7,200 | - | --[a] | --[a] |

[a]No additional pumping needed for this efficiency, therefore no change from non-project conditions.

Note: Figures are the changes from non-project conditions measured at the end of the year.

TABLE 28b.--Change in groundwater storage due to changing irrigation efficiency, Watershed B-7

| Water supply condition | Cropland irrigation efficiency | | |
|---|---|---|---|
| | 45% | 50% | 55% |
| | Ac. ft. | Ac. ft. | Ac. ft. |
| Average supply following average | 0 | -11,200 | -16,000 |
| Average supply following dry | 0 | -28,000 | -46,800 |
| Average supply following wet | 0 | -30,800 | -49,600 |
| 80 percent chance supply following average | 0 | -22,400 | -30,000 |
| 80 percent chance supply following dry | 0 | -26,800 | -45,600 |
| 80 percent chance supply following wet | 0 | -29,200 | -48,400 |
| 20 percent chance supply following average | 0 | -21,200 | -34,400 |
| 20 percent chance supply following dry | 0 | -28,800 | -48,800 |
| 20 percent chance supply following wet | 0 | -30,400 | -49,600 |
| Pumping Projects | | | |
| Average supply following average | -24,000 | -25,200 | -25,600 |
| 80 percent chance supply following average | -51,600 | -54,400 | -54,400 |
| 20 percent chance supply following average | -28,000 | --[a] | --[a] |

[a]No additional pumping needed for this efficiency.

Note: Figures are the changes from non-project conditions measured at the end of the year.

TABLE 29a.--Annual change in outflow from non-project conditions, Watersheds B-5 and 6

| Water supply condition | Non-project outflow[a] | Cropland irrigation efficiency | | |
|---|---|---|---|---|
| | | 30% | 40% | 50% |
| | | Ac. ft. | Ac. ft. | Ac. ft. |
| Average supply following average | 50,000 | -3,000 | -8,700 | -11,000 |
| Average supply following dry | 43,000 | -2,000 | -5,200 | -8,200 |
| Average supply following wet | 59,000 | -2,600 | -4,800 | -5,600 |
| 80 percent chance supply following average | 45,000 | -1,000 | -3,600 | -6,000 |
| 80 percent chance supply following dry | 38,500 | -2,000 | -5,000 | -7,800 |
| 80 percent chance supply following wet | 54,500 | -2,400 | -5,500 | -6,800 |
| 20 percent chance supply following average | 57,000 | -1,400 | -4,000 | -5,300 |
| 20 percent chance supply following dry | 50,500 | -2,500 | -5,400 | -7,900 |
| 20 percent chance supply following wet | 66,500 | -2,500 | -3,800 | -4,400 |
| Pumping Projects | | 22.4% | 40% | 50% |
| Average supply following average | | -1,800 | -2,200 | - |
| 80 percent chance supply following average | | -6,500 | -6,500 | -6,500 |
| 20 percent chance supply following average | | -4,500 | - | - |

[a]Only groundwater outflow was considered here as the surface outflow was not effected by the projects investigated.

TABLE 29b.--Annual change in outflow from non-project conditions, Watershed B-7

| Water supply condition | Non-project outflow[a] | Cropland irrigation efficiency | | |
|---|---|---|---|---|
| | | | 50% | 55% |
| | | | Ac. ft. | Ac. ft. |
| Average supply following average | +9,280 | | -200 | -780 |
| Average supply following dry | +6,800 | | -1,000 | -1,650 |
| Average supply following wet | +9,600 | | -900 | -1,750 |
| 80 percent chance supply following average | -6,650[b] | | -750 | -1,150 |
| 80 percent chance supply following dry | -8,250[b] | | -850 | -1,550 |
| 80 percent chance supply following wet | -5,150[b] | | -1,100 | -1,750 |
| 20 percent chance supply following average | +16,600 | | -700 | -950 |
| 20 percent chance supply following dry | +15,600 | | -1,000 | -1,550 |
| 20 percent chance supply following wet | +18,450 | | -850 | -1,500 |
| Pumping Projects | | 45% | 50% | 55% |
| Average supply following average | | -800 | -750 | -750 |
| 80 percent chance supply following average | | -1,600 | -1,600 | -1,600 |
| 20 percent chance supply following average | | -1,100 | -- | -- |

[a]Central Utah Canal outflow from Watershed B-6 is included in these figures.

[b]See the "Discussion of Results" for explanation of negative values.

## DISCUSSION OF RESULTS

Figure 15 illustrates the relation between the root zone deficit or surplus and the irrigation efficiency for the cropland areas with no net change in soil moisture storage during the year. Under natural conditions, there generally is a difference in the soil moisture storage level between the beginning and end of the year. However, a net increase should be considered part of the surplus and a net decrease part of the deficit. Figure 15 can be used to determine the approximate root zone deficit or surplus for any given irrigation efficiency and water supply condition. These curves can also be used to determine the amount of additional land that can be irrigated or possible reductions in the amount of water diverted.

The Sub-basin B analog model illustrates that the amount of wetland consumptive use is not the same for all levels of water supply. When the water supply was reduced in the model to represent the 80 percent chance supply, the total annual outflow became negative which is physically impossible. (See Table 29b.) This indicates the use was excessive with respect to the supply. Since the cropland use was adjusted for the reduced supply, the wetland use, as computed, must have been too high. Although the model did not allow for a reduced wetland area use, the change in outflow and groundwater storage shown in Tables 27 through 29 can still be used to good advantage by recognizing that part of the change would actually be a reduction in wetland use.

Since the outflow from Watersheds B-5 and 6 becomes the inflow into Watershed B-7, some of the effects of project measures in B-5 and 6 would be carried over into B-7. Tables 28a and 29a reflect the project effects in B-7 as well as carry-over effects from B-5 and 6. When computing the results displayed in Tables 28b and 29b, Watershed B-5 and 6 irrigation efficiencies of 22.4 percent, 40 percent and 50 percent were used to correspond to the 45 percent, 50 percent and 55 percent efficiencies of B-7.

Analysis of the data in Tables 27, 28a and 28b reveals several significant relationships relative to changes in groundwater storage caused by improving irrigation efficiencies and by natural variations in water supply. Table 30 shows these relationships. However, if the resultant changes in wetland consumptive use were accounted for, the figures would be slightly reduced. Also, these relationships are valid only until the cropland root zone is filled. After that, increased irrigation efficiency has much less additional effect on the groundwater storage level.

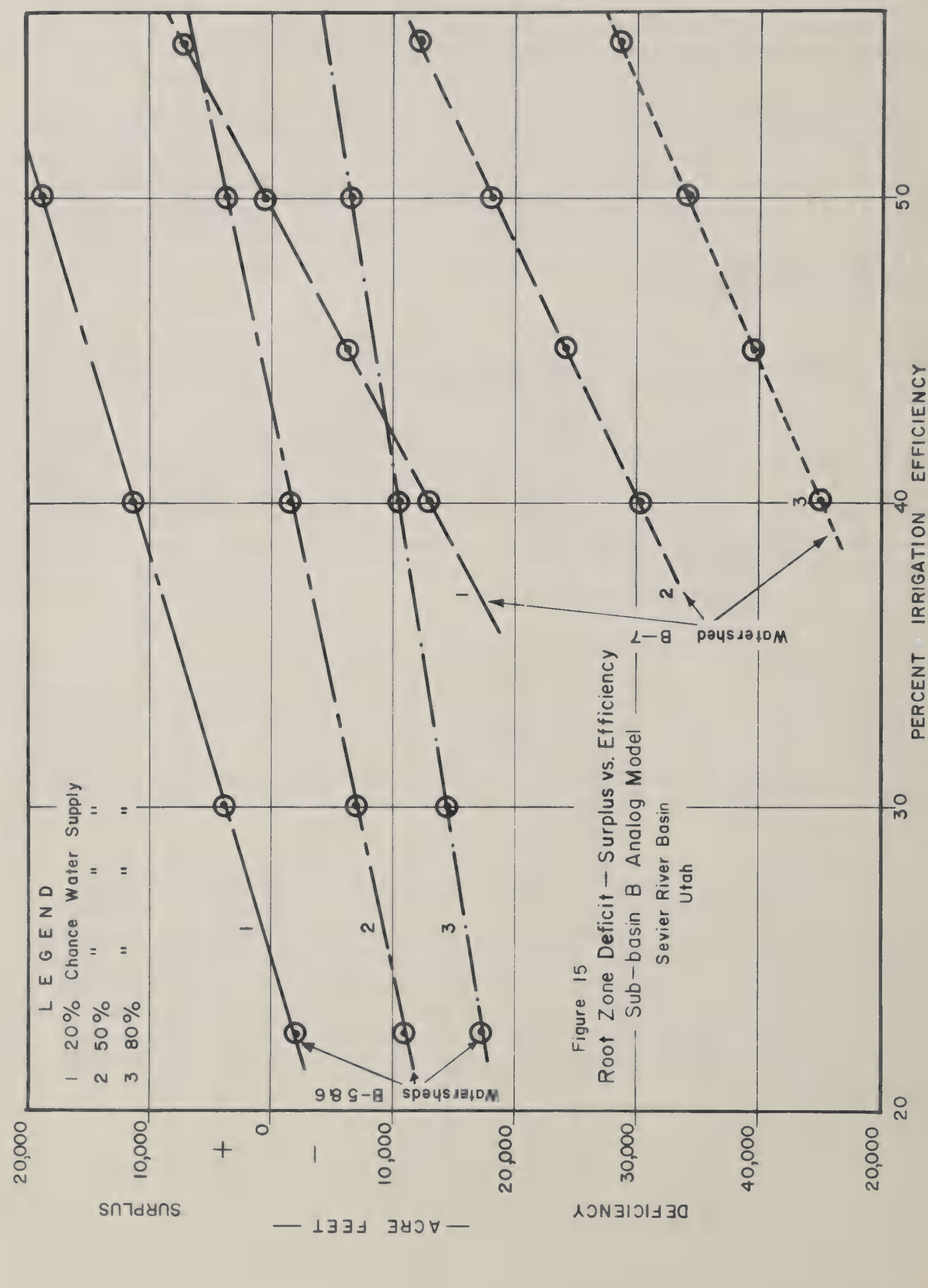



Figure 15
Root Zone Deficit — Surplus vs. Efficiency
— Sub-basin B Analog Model —
Sevier River Basin
Utah

TABLE 30.--Generalized changes in groundwater storage caused by different supply variations

| Type of variation | Resultant change in storage | |
|---|---|---|
| | Watersheds B-5 and 6 | Watershed B-7 |
| | Acre-feet | Acre-feet |
| Increase in irrigation efficiency: | | |
| 10% in B-5 & 6 and 5% in B-7 | -6,000 | -19,000 |
| Change from average water supply: | | |
| to 80% chance (dry) | -18,000 | -32,000 |
| to 20% chance (wet) | +26,000 | +34,000 |
| Change of supply in previous year: | | |
| from average to wet or dry | ±10,000 | ±6,000 |

A pumping project to overcome the root zone deficit showed about the same effect on groundwater storage regardless of irrigation efficiency as potential consumptive use was satisfied in all cases. In Watersheds B-5 and 6, such a pumping project reduced the groundwater storage about 18,000, 10,000 and 7,000 acre-feet for 80 percent chance, average, and 20 percent chance water supplies, respectively. In Watershed B-7, these changes were 54,000, 25,000 and 28,000 acre-feet for the corresponding water supplies. The figures for Watershed B-7 reflect the project effects in both areas. The increase in quantities pumped for each water supply condition are shown in Table 25.

Table 31 shows the changes in outflow caused by changing irrigation efficiencies and by natural variations in water supplies. The limitations discussed in connection with Table 30 also apply to the change in outflow relationships shown here. Only annual outflow figures are shown in Tables 29a, 29b and 31 because they are primarily groundwater flows and nearly uniform throughout the year.

The figures in Tables 30 and 31, even though they are approximate, illustrate how natural variations in water supply could have greater effects on such hydrologic factors as groundwater storage and watershed outflow, than a water conservation or development project installed within the watershed. This could cause difficulty in measuring the effects of an installed project. The relation developed in this study would be helpful in predicting what those effects would be, where to look for them, and their probable magnitude.

TABLE 31.--Generalized changes in outflow caused by differenct supply conditions

| Type of variation | Resultant change in outflow: Watersheds B-5 & 6 | Resultant change in outflow: Watershed B-7 |
|---|---|---|
| | Acre-feet | Acre-feet |
| Increase in irrigation efficiency | | |
| 10% in B-5 & 6 and 5% in B-7 | -2,700 | -700 |
| Change from average water supply | | |
| to 80% chance (dry) | -5,000 | -15,000 |
| to 20% chance (wet) | +7,000 | +8,000 |
| Change of supply in previous year | | |
| from average to wet or dry | ±8,000 | ±2,000 |
| Pumping project | | |
| Average water supply | -2,000 | -800 |
| 80% chance water supply | -6,500 | -1,600 |
| 20% chance water supply | -4,500 | -1,100 |

# CHAPTER VI

## SUB-BASINS A, C AND D ANALOG MODELS

### DESCRIPTION OF THE MODELS

A generalized analog model of the valley portions of Sub-basins A and C and Watersheds D-1 through D-5 was programmed to study the hydrologic interrelationships and effects of possible projects. This model was designed to analyze project coordination between these areas and to investigate the effect on wetland areas of water conservation projects installed on the adjacent cropland. Since this was the last model programmed, it included all of the circuit improvements developed for previous models along with a new circuit analyzing the reduction in wetland consumptive use as the groundwater supply is reduced. This new circuit is described in detail later.

General Hydrologic Simulation.-- The circuitry consisted of a generazlized hydrologic model of each of the three sub-basins, interconnected so that the outflow, both surface and groundwater, from Sub-basins A and D became the inflow into Sub-basin C. Outflow from Sub-basin C corresponded to the inflow into Sevier Bridge Reservoir. The model of each sub-basin consisted of circuits simulating the cropland area, wetland area and groundwater basin with the inputs, water supply depletions, and outflows needed to represent each area. It was necessary to use the same monthly distribution of precipitation, tributary runoff, cropland potential consumptive use, and wetland potential consumptive use for all three sub-basins. (Figures 16 through 22).

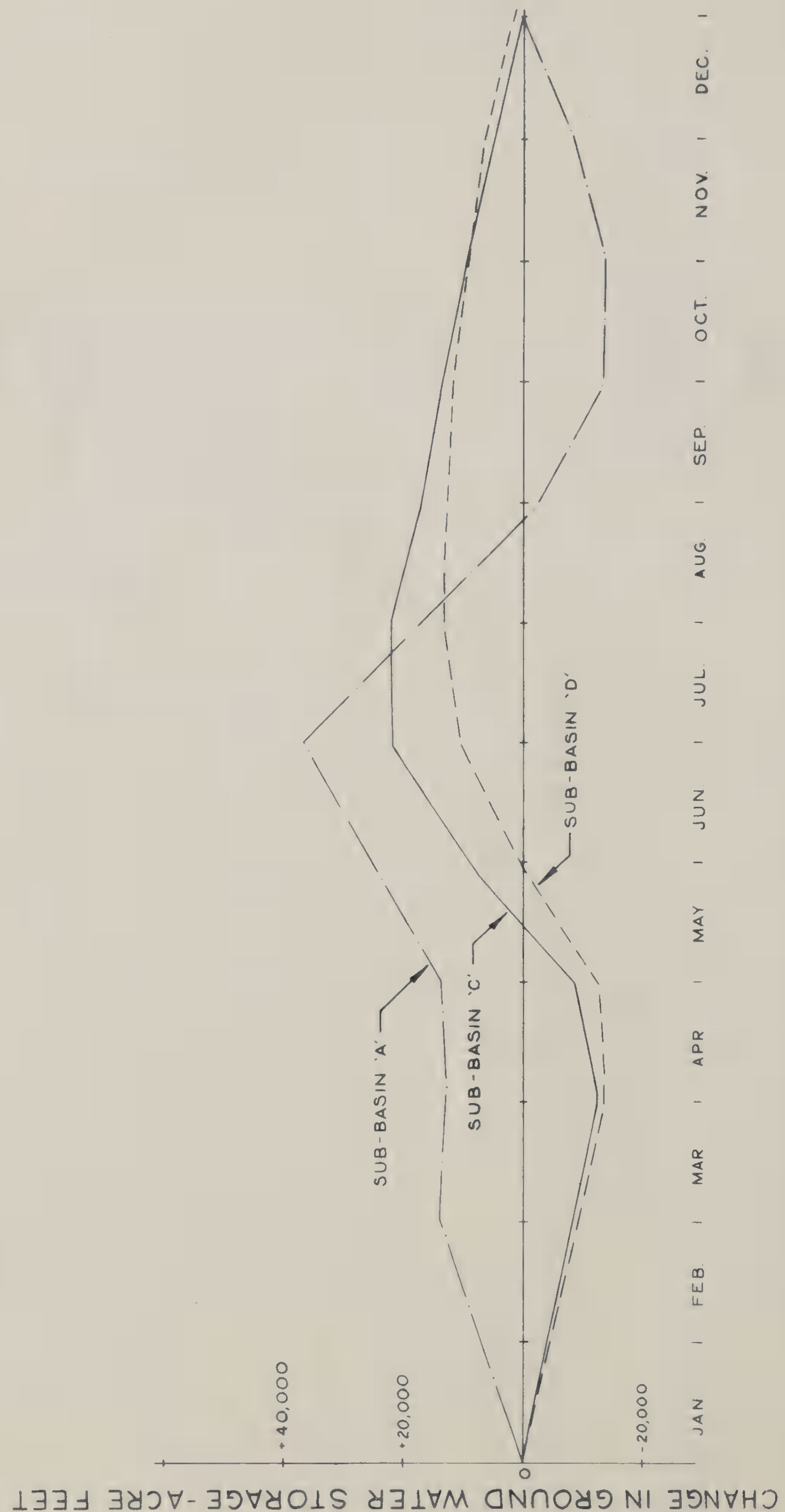



FIGURE: 16 SUB-BASINS A, C, & D ANALOG MODEL - GROUND WATER STORAGE

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN
UTAH


FIGURE: 17 SUB-BASINS A, C, & D ANALOG MODEL - SOIL MOISTURE STORAGE

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN
UTAH

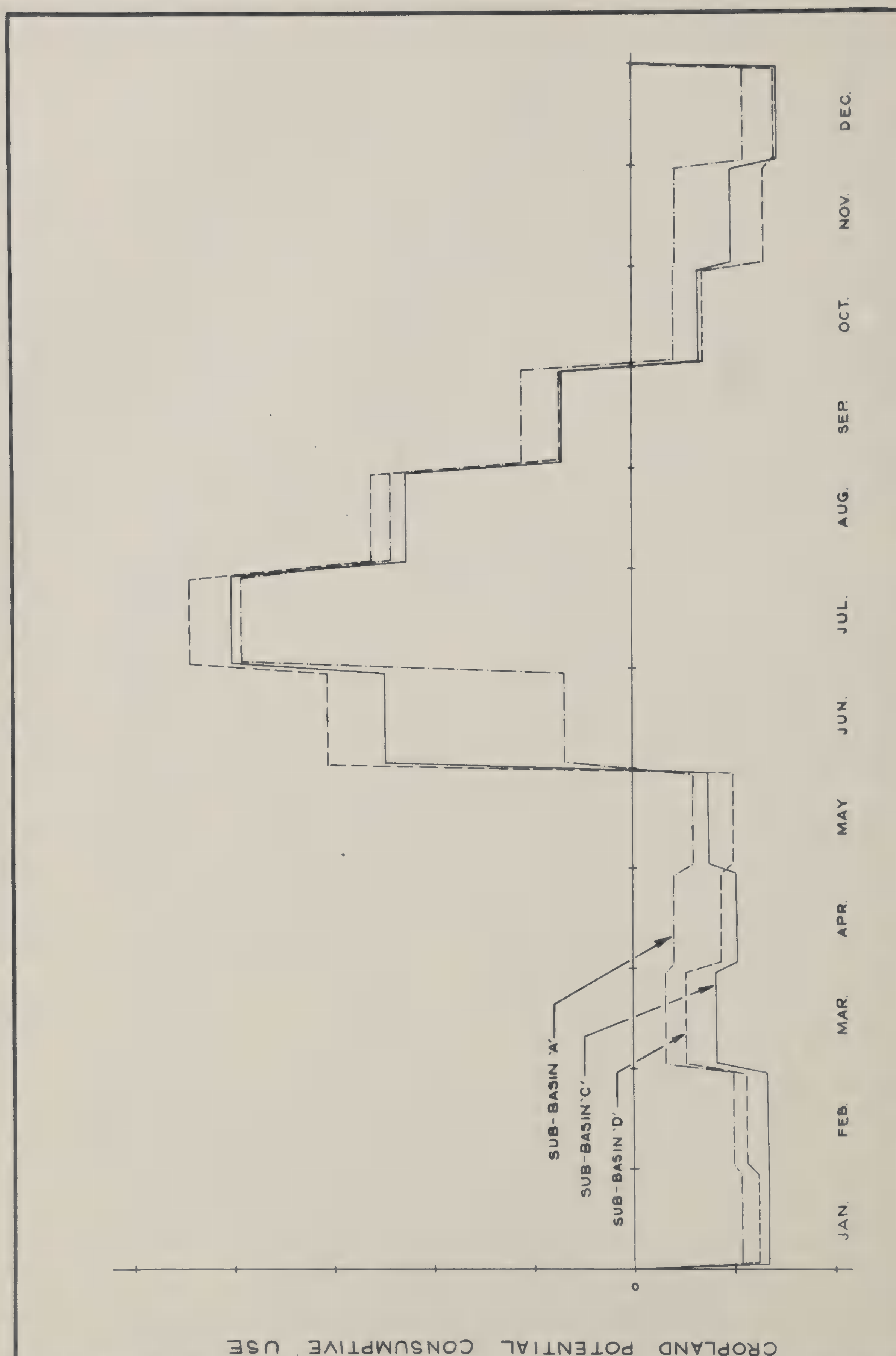



FIGURE: 18 SUB-BASINS A, C, & D ANALOG MODEL - CROPLAND POTENTIAL CONSUMPTIVE USE
AVERAGE ANNUAL WATER SUPPLY
SEVIER RIVER BASIN
UTAH

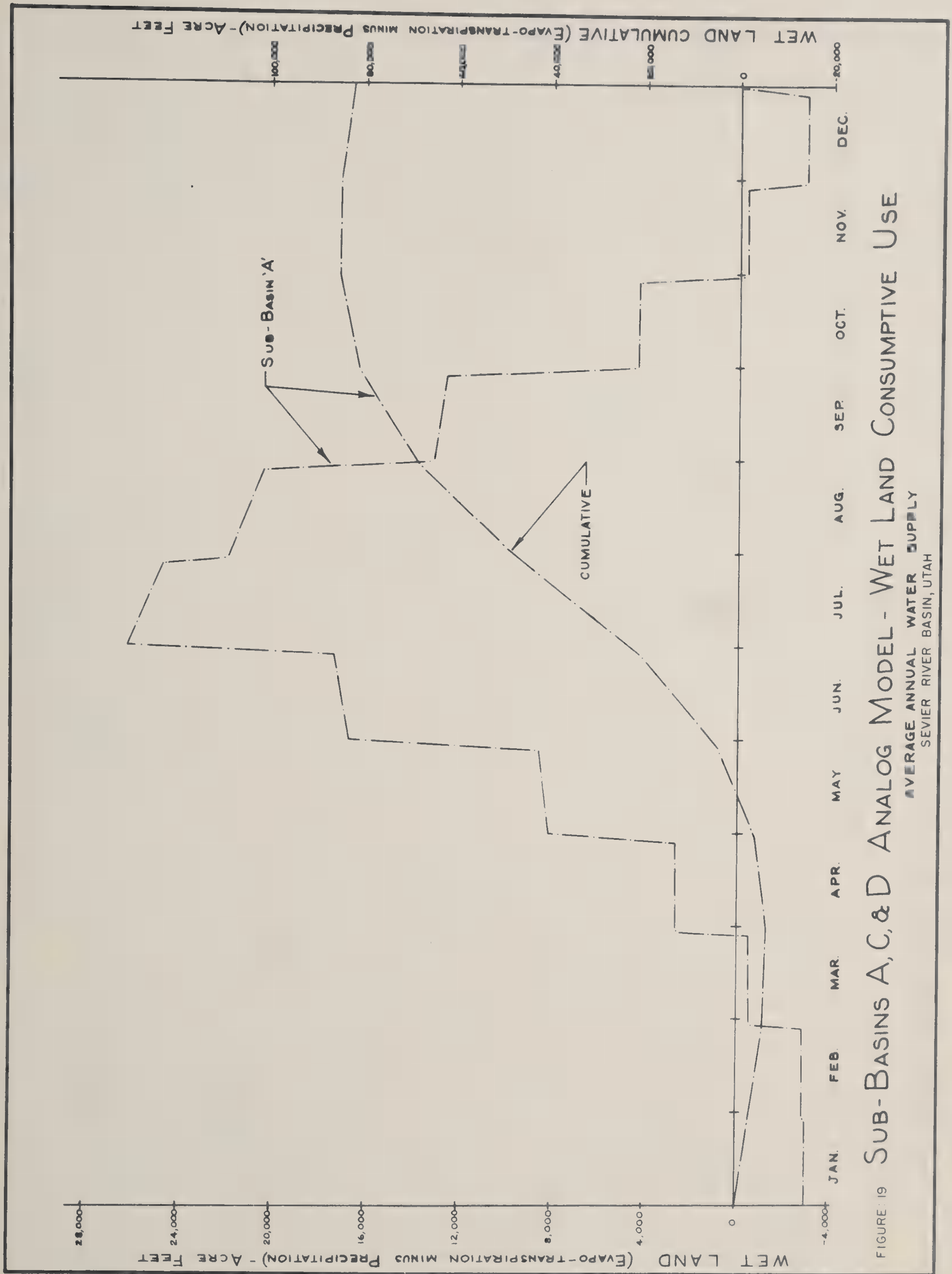



FIGURE 19 SUB-BASINS A, C, & D ANALOG MODEL - WET LAND CONSUMPTIVE USE
AVERAGE ANNUAL WATER SUPPLY
SEVIER RIVER BASIN, UTAH

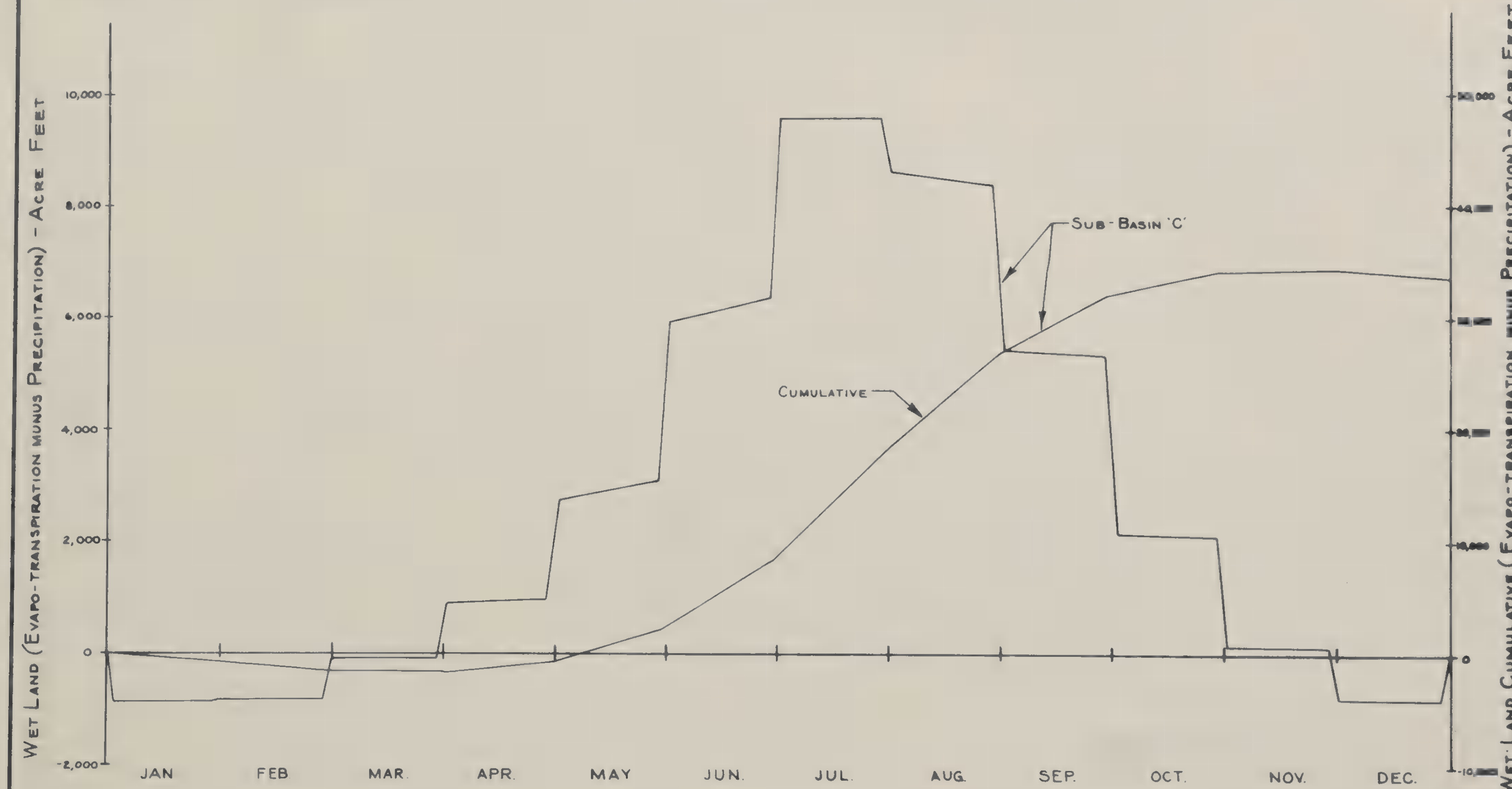



FIGURE: 20 SUB-BASINS A, C, & D ANALOG MODEL - WET LAND CONSUMPTIVE USE

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN

UTAH

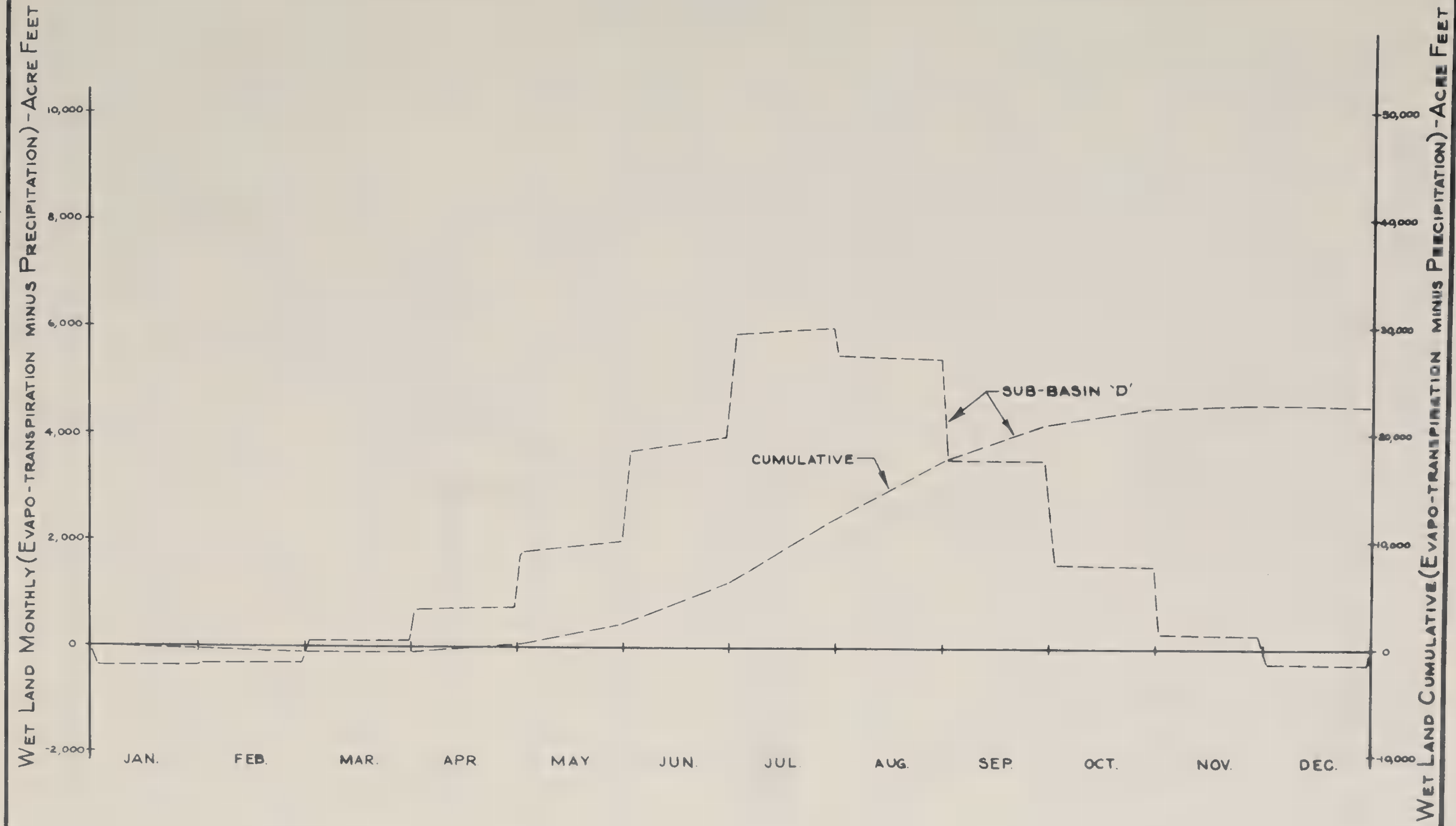
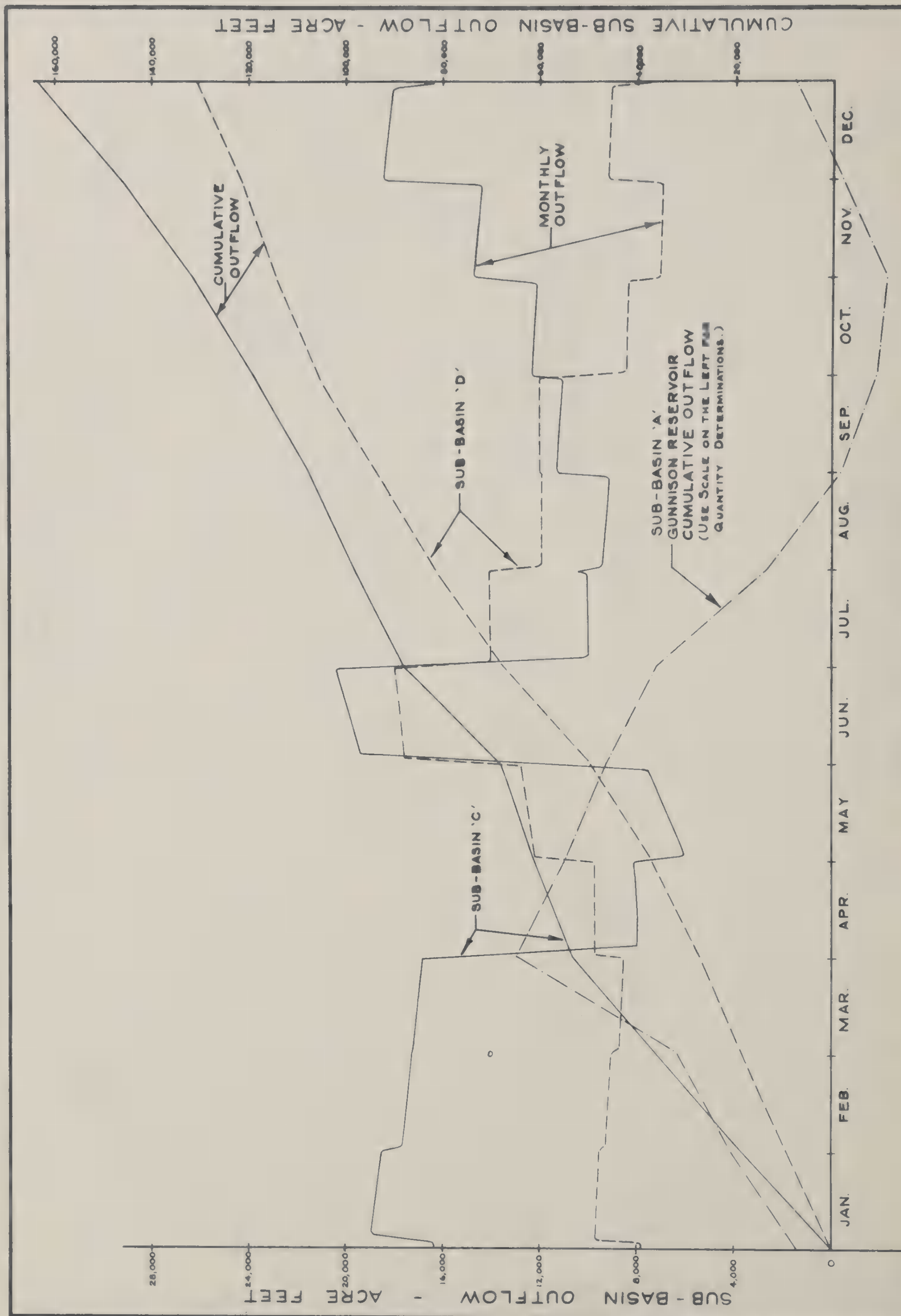



FIGURE: 21 SUB-BASINS A, C, & D ANALOG MODEL - WET LAND CONSUMPTIVE USE

AVERAGE ANNUAL WATER SUPPLY

SEVIER RIVER BASIN

UTAH




SEVIER RIVER BASIN, UTAH

FIGURE: 22 SUB-BASINS A,C, & D ANALOG MODEL - OUTFLOW (CUMULATIVE & MONTHLY)

AVERAGE ANNUAL WATER SUPPLY

The data used to describe the hydrologic conditions of Sub-basins A, C and D were the same as that developed for the average annual water budgets with minor adjustments. Factors with variable monthly values are described below with the corresponding data shown in Table 32.

1. Total canal diversions to the cropland, in acre-feet.

2. Irrigation water pumped from wells plus direct use from groundwater by crops growing over a shallow water table, in acre-feet.

3. Cropland potential consumptive use, in inches, for Sub-basin C (the same values were used for Sub-basin D but were adjusted in the model for Sub-basin A).

4. River inflow, in acre-feet.

5. Tributary runoff, in acre-feet, for Sub-basin A (these values were adjusted in the model for Sub-basins C and D).

6. Precipitation, in inches, on the Sub-basin A cropland area (the same values were used for Sub-basin C cropland but were adjusted on Sub-basin D cropland and on all wetland areas).

7. Wetland potential consumptive use, in inches, for Sub-basin C (the same values were used for Sub-basin D but were adjusted for Sub-basin A).

8. Distribution of the wetland potential consumptive use, in percent per month.

9. Releases from, and groundwater flow past Gunnison Reservoir, in acre-feet.

10. Difference between evaporation and precipitation on Gunnison Reservoir, in inches.

The outflow from Sub-basins C and D and the change in storage and capacity of Gunnison Reservoir were used for calibration purposes but were not programmed into the model.

The hydrologic values which did not change during the year are shown in Table 33. Those values of reasonable accuracy not changed during the calibration of the model are described on the following page.

TABLE 32.-Hydrologic factors which vary monthly

| | Sub-basin D Diversions | | Sub-basin D Pumping + UFGW[a] | | Sub-basin C Diversions | | Sub-basin C Pumping + UFGW[a] | | Sub-basin A Diversions | | Sub-basin A Pumping + UFGW[a] | | Cropland PCU[b] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 2,020 | 2.02 | 170 | .34 | 2,820 | 2.82 | 150 | .30 | - | - | - | - | .18 | .90 | | |
| 2 | 1,830 | 1.83 | 310 | .62 | 3,260 | 3.26 | 350 | .70 | - | - | - | - | .34 | 1.70 | | |
| 3 | 3,110 | 3.11 | 890 | 1.78 | 4,620 | 4.62 | 1,180 | 2.36 | - | - | - | - | .89 | 4.45 | | |
| 4 | 12,550 | 12.55 | 1,930 | 3.86 | 17,230 | 17.23 | 2,450 | 4.90 | 10,360 | 10.36 | 2,550 | 5.10 | 1.69 | 8.45 | | |
| 5 | 28,080 | 28.08 | 4,010 | 8.02 | 34,330 | 34.33 | 4,890 | 9.78 | 34,770 | 34.77 | 5,220 | 10.44 | 3.34 | 16.70 | | |
| 6 | 25,980 | 25.98 | 6,220 | 12.44 | 31,990 | 31.99 | 7,990 | 15.98 | 49,590 | 49.59 | 11,500 | 23.00 | 5.94 | 29.70 | | |
| 7 | 25,640 | 25.64 | 7,480 | 14.96 | 27,600 | 27.60 | 10,120 | 20.24 | 19,940 | 19.94 | 14,960 | 29.92 | 7.05 | 35.25 | | |
| 8 | 20,070 | 20.07 | 5,980 | 11.96 | 20,200 | 20.20 | 8,390 | 16.75 | 11,640 | 11.64 | 12,310 | 24.62 | 5.11 | 25.55 | | |
| 9 | 16,300 | 16.30 | 3,710 | 7.42 | 16,520 | 16.52 | 5,090 | 10.18 | 9,030 | 9.03 | 6,920 | 13.84 | 2.98 | 14.90 | | |
| 10 | 10,010 | 10.01 | 1,750 | 3.50 | 10,210 | 10.21 | 2,570 | 5.14 | 9,280 | 9.28 | 1,280 | 2.56 | 1.54 | 7.70 | | |
| 11 | 6,800 | 6.80 | 530 | 1.06 | 5,430 | 5.43 | 750 | 1.50 | - | - | - | - | .54 | 2.70 | | |
| 12 | 2,970 | 2.97 | 220 | .44 | 3,350 | 3.35 | 280 | .56 | - | - | - | - | .22 | 1.10 | | |

| | River Inflow | | Sub-basin A TRO[c] | | Precipitation | | Wetland PCU[b] | | Percentage PCU per month | | Sub-basin A Outflow | | Evap.-Precip. Gunnison Res. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts | Actual Value | Volts |
| 1 | 2,920 | 2.92 | 6,620 | 6.62 | 1.04 | 10.4 | .24 | 1.20 | .62 | 1.24 | 130 | .52 | - 40 | 4.60 | | |
| 2 | 2,540 | 2.54 | 6,350 | 6.35 | 1.13 | 11.3 | .39 | 1.95 | 1.00 | 2.00 | 120 | .48 | - 20 | 4.80 | | |
| 3 | 3,420 | 3.42 | 6,780 | 6.78 | 1.09 | 10.9 | 1.07 | 5.35 | 2.75 | 5.50 | 1,550 | 6.20 | 100 | 6.00 | | |
| 4 | 13,570 | 13.57 | 9,070 | 9.07 | 1.01 | 10.1 | 1.99 | 9.95 | 5.12 | 10.24 | 3,080 | 12.32 | 300 | 8.00 | | |
| 5 | 25,960 | 25.96 | 34,530 | 34.53 | .92 | 9.2 | 3.62 | 18.10 | 9.30 | 18.60 | 3,350 | 13.40 | 530 | 10.30 | | |
| 6 | 25,660 | 25.66 | 47,760 | 47.76 | .77 | 7.7 | 5.92 | 29.60 | 15.21 | 30.42 | 1,850 | 7.40 | 820 | 13.20 | | |
| 7 | 27,582 | 27.58 | 18,320 | 18.32 | .75 | 7.5 | 8.51 | 42.55 | 21.87 | 43.74 | 5,040 | 20.16 | 880 | 13.80 | | |
| 8 | 21,660 | 21.66 | 9,830 | 9.83 | .93 | 9.3 | 7.89 | 39.45 | 20.28 | 40.56 | 3,070 | 12.28 | 640 | 11.40 | | |
| 9 | 18,450 | 18.45 | 8,250 | 8.25 | .67 | 6.7 | 5.18 | 25.90 | 13.31 | 26.62 | 2,250 | 9.00 | 580 | 10.80 | | |
| 10 | 8,650 | 8.65 | 7,860 | 7.86 | 1.05 | 10.5 | 2.81 | 14.05 | 7.22 | 14.44 | 710 | 2.84 | 280 | 7.80 | | |
| 11 | 4,430 | 4.43 | 7,290 | 7.29 | .84 | 8.4 | .93 | 4.65 | 2.39 | 4.78 | 70 | .28 | 100 | 6.00 | | |
| 12 | 2,950 | 2.15 | 7,020 | 7.02 | 1.09 | 10.9 | .36 | 1.80 | .93 | 1.86 | 90 | .36 | - 30 | 4.70 | | |

[a]UFGW = Use from groundwater directly by crops
[b]PCU = Potential consumptive use
[c]TRO = Tributary runoff

TABLE 33.--Hydrologic factors of constant value for the entire year

| Description of factor | Potentiometer number | Actual value | Potentiometer setting[a] |
|---|---|---|---|
| Cropland area (acres) | | | |
| Sub-basin A | | 53,400 | |
| Sub-basin C | | 48,500 | |
| Sub-basin D | | 39,760 | |
| Wetland area (acres) | | | |
| Sub-basin A | | 47,140 | |
| Sub-basin C | | 14,020 | |
| Sub-basin D | | 8,600 | |
| Soil moisture-holding capacity (inches) | | | |
| Sub-basin A | 32 | 8.68 | 21.7 |
| Sub-basin C | 27 | 9.00 | 22.5 |
| Sub-basin D | 26 | 8.68 | 21.7 |
| Canal water irrigation efficiency (percent) | | | |
| Sub-basin A | 55 | 27.8 | 13.9 |
| Sub-basin C | 50 | 29.4 | 14.7 |
| Sub-basin D | 2 | 34.3 | 17.15 |
| Pumped water irrigation efficiency (inches) | | | |
| Sub-basin A | 57 | 40.0 | 20.0 |
| Sub-basin C | 52 | 42.0 | 21.0 |
| Sub-basin D | 4 | 36.0 | 18.0 |
| Percent of outflow as surface water | | | |
| Sub-basin D | 11 | 90.0 | 45.0 |
| Percent of outflow as groundwater | | | |
| Sub-basin D | 12 | 10.0 | 5.0 |
| Tributary runoff adjustment | | | |
| Sub-basin C | 21 & 22 | 0.669 | ---[b] |
| Sub-basin D | 9 & 10 | 0.365 | ---[b] |
| Cropland consumptive use adjustment | | | |
| Sub-basin A | 58 | 0.935 | 46.75 |
| Wetland consumptive use adjustment | | | |
| Sub-basin A | 38 | 0.793 | ---[c] |
| Precipitation adjustment-cropland | | | |
| Sub-basin D | 7 | 0.726 | 36.3 |
| Precipitation adjustment-wetland | | | |
| Sub-basin A | 37 | 0.917 | ---[c] |
| Sub-basin C | 35 | 0.919 | ---[c] |
| Sub-basin D | 31 | 0.687 | ---[c] |
| Percent of surface flow tributary runoff | | | |
| Sub-basin C | 21 | 0.75 | ---[b] |
| Sub-basin D | 9 | 0.60 | ---[b] |
| Percent of groundwater flow tributary runoff | | | |
| Sub-basin C | 22 | 0.25 | ---[b] |
| Sub-basin D | 10 | 0.40 | ---[b] |
| Flow from groundwater basin | | | |
| Sub-basin A | 65 | 0.15 | 7.5 |
| Sub-basin C | 20 | 0.31 | 15.5 |
| Sub-basin D | 13 | 0.25 | 12.5 |
| Factor to convert change in groundwater storage to change in consumptive use | | | |
| Sub-basin A | 43 | 0.52 | 26.0 |
| Sub-basin C | 34 | 0.62 | 31.0 |
| Sub-basin D | 29 | 0.95 | 47.5 |
| Average groundwater level | | | |
| Sub-basin A | 71 | 32.1 | 32.1 |
| Sub-basin C | 17 | 33.4 | 33.4 |
| Sub-basin D | 16 | 30.1 | 30.1 |

[a]Arm voltage when high side was connected to 50 volts.

[b]This factor was combined with another tributary runoff factor.

[c]These factors were combined with acreage adjustment factors.

1. Cropland and wetland areas, in acres.

2. Root-zone moisture holding capacity of the cropland, in inches.

3. Canal and pumped irrigation water efficiencies.

4. Ratio of groundwater to surface water outflow from Sub-basin D into Sub-basin C.

5. Ratio of the normal annual tributary runoff in Sub-basin A to that in Sub-basin C and in Sub-basin D.

6. Ratio of the cropland annual potential consumptive use in Sub-basin C to Sub-basin A.

7. Ratio of the wetland annual potential consumptive use in Sub-basin C to Sub-basin A.

8. Ratios of annual precipitation on Sub-basins A and C cropland to that on Sub-basin D cropland and on the wetland areas.

Inadequate information required preliminary estimates of some values. These were then determined more accurately by trial and error during the calibration of the model. These values were:

1. The percent of tributary runoff which enters the valley as surface flow and as groundwater flow in each sub-basin.

2. The relationship between the amount of groundwater in storage and the flow from the groundwater basin into the river.

3. The relationship between a change in groundwater storage and the resulting change in wetland consumptive use.

4. The average groundwater level for each sub-basin.

Groundwater Reservoir Circuit.--The circuits used to simulate the groundwater reservoirs for each of the three sub-basins were made up of an integrating circuit functioning as a storage device. This circuit would sum the inflows to and outflows from the groundwater reservoirs and indicate the volume change in storage. A potentiometer setting provided an approximate relationship between the flow from the groundwater reservoir and the volume of water in storage.

Wetland Area Circuit.--The analog model for Sub-basins A, C and D was the first attempt made to program the reduction in wetland consumptive use resulting from a reduction in the groundwater reservoir level. As originally developed, the system did not allow

for a variation in wetland consumptive use. This had been recognized as a problem, especially when extensive pumping projects were investigated. Although the solution was approximate, more satisfactory results were obtained.

The reduced volume in groundwater storage was used to indicate both the lowering of the water table and the reduction in artesian pressure whether caused by a reduced supply to or an increased use from the groundwater reservoir. The resulting change in the volume of water consumed is caused both by a decrease in acreage of the wetlands and by a reduction in on-site rates. The method used to simulate this situation did not separate the amount of consumptive use change which resulted from each source, but assumed a volume change in use would result from a computed volume change in groundwater storage.

To accomplish the purpose of this study, it was necessary to develop an equation which would not only simulate the relationship between a change in groundwater storage and a change in wetland consumptive use, but which would also be convenient to program on analog computer type equipment. The equation used for the Subbasin A, C and D model was:

$$CU=PCU - \left[ C(MPCU) \quad (GW_{avg}-GW_p) \right]$$

where CU = actual consumptive use by months in the wetland area

PCU = potential consumptive use by months computed for the area based on non-project conditions.

C = factor to convert a change in groundwater storage to change in consumptive use.

MPCU = the percent that each month's potential consumptive use is of the total annual potential consumptive use.

$GW_{avg}$ = average groundwater storage level as computed in the model for non-project conditions.

$GW_p$ = groundwater storage level as computed in the model for project conditions.

The MPCU factor was included because the actual reduction in consumptive use for any one month is related to the potential use for that month as well as to the change in groundwater storage from the average.

The average groundwater storage levels were determined by calibrating the analog model with the consumptive use adjustment circuits disconnected and using non-project conditions. This established a standard from which changes in groundwater storage under project conditions could be measured. With the consumptive use adjustment circuits connected, the potentiometer settings "C" and the various amplifier gains within the circuits were adjusted as necessary to produce the approximated relationship between the change in groundwater storage and the change in wetland consumptive use shown in Table 34.

This relationship was considered linear within the range of variations encountered. The reduction in consumptive use is different in each of the three sub-basins for the same reduction in groundwater storage because of varying ratios between the wetland area and the groundwater basin.

## CONDITIONS INVESTIGATED

For the combined Sub-basins A, C and D analog model, only the average annual level of water supply and use was programmed. Various types of pojects and levels of project improvements were programmed and the results analyzed in order to obtain a range of hydrologic effects on the area. The range of effects thus obtained can be utilized when the impacts of any particular project are being investigated.

The conditions imposed are described below:

1. A canal diversion to root-zone irrigation efficiency of 40 percent with no change in cropland acreage or pumped irrigation water efficiency.

2. A canal diversion to root-zone irrigation efficiency of 50 percent with no change in cropland acreage or pumped irrigation water efficiency.

3. Same as condition 1 with diversions reduced until the supply to root-zone equaled the consumptive use. (Table 35).

4. Same as condition 2 with diversions reduced until the supply to root-zone equaled the consumptive use and eliminating direct use from groundwater by irrigated crops. (Table 35).

5. Canal irrigation water use efficiency of 40 percent, pumped irrigation water efficiency of 50 percent, average annual canal diversions, no direct use from groundwater by irrigated crops, increased cropland

TABLE 34.--Modeled relationship between change in groundwater storage and change in wetland consumptive use

| Sub-basin | Groundwater basin area | Wetland consumptive use[a] | Change in groundwater storage[b] | | |
|---|---|---|---|---|---|
| | | | Change in water table | Change in consumptive use | |
| | Acres | Acre-feet | Feet | Percent | Acre-feet |
| A | 100,000 | 82,400 | 2.5 | 20 | 16,500 |
| C | 60,000 | 33,700 | 4.2 | 33 | 11,200 |
| D | 50,000 | 22,500 | 5 | 40 | 9,000 |

[a]Does not include precipitation.

[b]Values reflect the change in water table levels and consumptive use resulting from a change in groundwater of 50,000 acre-feet.

TABLE 35.--Reduced average diversions for conditions 3 and 4[a]

| Sub-basin | Jan. | Feb. | March | April | May | June | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| Condition 3 | | | | | | | | | |
| A | - | - | - | 3,340 | 10,010 | 2,350 | - | - | 15,700 |
| C | 2,820 | 3,260 | 4,620 | 8,730 | 9,330 | - | 3,430 | 3,350 | 35,540 |
| D | - | - | - | 2,550 | 3,080 | - | - | - | 5,630 |
| Condition 4 | | | | | | | | | |
| A | - | - | - | - | 5,000 | 4,000 | - | - | 9,000 |
| C | 2,000 | 3,000 | 3,000 | 8,000 | 6,000 | - | 3,000 | 2,000 | 27,000 |
| D | - | - | 1,000 | 5,000 | 7,000 | - | - | - | 13,000 |

[a]See page 93 for description of conditions.

area of 10,000 acres in Sub-basin A and D and 15,000 acres in Sub-basin C, and increased pumped water volumes as shown in Table 36.

6. Same as for condition 5 except with canal irrigation water use efficiency of 50 percent (Table 36).

TABLE 36.--Increased average diversions pumped from wells for conditions 5 and 6[a]

| Sub-basin | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| Condition 5 | | | | | | |
| A | 6,500 | 12,000 | 12,000 | 11,000 | 3,000 | 44,500 |
| C | 6,000 | 12,500 | 15,000 | 15,000 | 5,000 | 53,500 |
| D | 6,000 | 13,000 | 15,000 | 15,000 | 5,500 | 54,500 |
| Condition 6 | | | | | | |
| A | 3,000 | 4,000 | 4,000 | 4,000 | 1,000 | 16,000 |
| C | - | 3,000 | 7,000 | 6,000 | 2,000 | 18,000 |
| D | - | 3,000 | 8,500 | 8,000 | 2,000 | 21,500 |

[a]See condition 5 on page 93 and condition 6 above.

SUMMARY OF RESULTS

During the calibration of the Sub-basins A, C and D analog model, it was determined that the cropland consumptive use deficit varied from the deficit as computed in the average annual water budgets by the amounts shown in Table 37.

TABLE 37.--Cropland deficits for average water supply

| Sub-basin | Analog study deficit | Average annual water budgets | | |
|---|---|---|---|---|
| | | Deficit | Surplus | Difference |
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| A | 10,000 | 13,750 | 1,990 | 11,760 |
| B | 3,400 | 9,090 | 5,920 | 3,170 |
| D | 6,700 | 9,290 | 2,780 | 6,510 |

The analog model study deficits were determined by combining the irrigation water supplies and uses for the total cropland area of each sub-basin. The average annual water budget deficits and surpluses were determined for each watershed and then totaled for the sub-basin. Therefore, the differences between the deficits and surpluses from the average annual water budgets should be compared with the deficits from the analog study. The small discrepancies observed in this comparison were due to errors inherent in the analog equipment.

The relationships between tributary surface water and groundwater runoff determined during calibration were 60 percent surface water flow and 40 percent groundwater flow for Sub-basin D and 75 percent surface water flow and 25 percent groundwater flow for Sub-basin C. Sub-basin A could not be calibrated using any set percentages for the entire year. In Sub-basin A, the total tributary runoff for March through October was routed as surface water flow and as groundwater flow for the balance of the year. This situation indicates that a high percentage of the tributary runoff (more than 90 percent) comes as surface water flows. During the winter months the surface water flow is diverted into the irrigation systems for stock water purposes and eventually seeps into the groundwater reservoir. This winter stock water was included in the irrigation diversions in the Sub-basins C and D data but not in the Sub-basin A data.

Calibration of the model showed that a 10,000 acre-foot change in the volume of groundwater storage in each sub-basin produced the following monthly change in return flows to the river:

Sub-basin A - 150 acre-feet
Sub-basin C - 600 acre-feet
Sub-basin D - 500 acre-feet

Due to a lack of more exact information these relationships were considered linear in the range of changes in groundwater storage encountered in this study. The different relationships resulted from differences in areal extent of the groundwater reservoirs and differences in groundwater basin characteristics.

In order to calibrate the Sub-basin A portion of the model, it was necessary to change the monthly distribution of the tributary runoff from that used for the average annual water budgets. It should be noted the change was only in time distribution and not in total annual volume.

Tables 38 through 41 give a montly and annual summary of the measureable effects of the project conditions previously discussed.[a] Each table shows the results of the average annual and changed project conditions. The results of the average annual and conditions 1 and 2 are shown in Table 38.

[a]Conditions investigated, pages 93 and 95.

TABLE 38.--Cropland consumptive use deficit and addition to groundwater

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | - | Ac. ft. | Ac. ft. | - | - | Ac. ft. | Ac. ft. |
| Sub-basin A | | | | | | | | | | | | | |
| Average Annual Conditions | - | - | - | - | - | - | - | -6,050 | -3,950 | - | - | - | -10,000 |
| Condition No. 1 | - | - | - | - | +2,850 | +3,450 | - | - | - | - | - | - | + 6,300 |
| Condition No. 2 | - | - | - | +3,000 | +9,900 | +8,600 | - | - | - | - | - | - | +21,500 |
| Sub-basin C | | | | | | | | | | | | | |
| Average Annual Conditions | - | - | - | - | - | - | - | -1,100 | -2,300 | - | - | - | -3,400 |
| Condition No. 1 | - | - | +3,150 | +5,150 | +6,000 | - | - | - | - | - | - | - | +14,300 |
| Condition No. 2 | +4,950 | +5,000 | +3,650 | +6,900 | +9,550 | - | - | - | - | - | - | +2,950 | +33,000 |
| Sub-basin D | | | | | | | | | | | | | |
| Average Annual Conditions | - | - | - | - | - | - | - | -4,800 | -1,900 | - | - | - | - 6,700 |
| Condition No. 1 | - | - | - | - | +3,000 | - | - | - | - | - | - | - | + 3,000 |
| Condition No. 2 | +3,350 | +3,300 | +2,000 | +4,550 | +7,700 | - | - | - | - | - | - | - | +20,900 |

Note: Negative values are consumptive use deficits. Positive values are losses to groundwater through deep percolation.

TABLE 39.--Change in wetland consumptive use

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| Sub-basin A | | | | | | | | | | | | | |
| Average Annual Use | 750 | 1,200 | 3,350 | 6,200 | 11,250 | 18,450 | 26,500 | 24,600 | 16,150 | 8,750 | 2,900 | 1,100 | 121,200 |
| Change due to Condition 1 | -50 | -100 | -250 | -450 | -850 | -1,350 | -1,900 | -1,800 | -1,250 | -700 | -150 | -50 | -8,900 |
| Change due to Condition 2 | -50 | -100 | -250 | -450 | -750 | -1,150 | -1,800 | -1,750 | -1,200 | -700 | -150 | -50 | -8,400 |
| Change due to Condition 3 | No results computed for this Condition | | | | | | | | | | | | |
| Change due to Condition 4 | -100 | -150 | -400 | -650 | -1,400 | -2,500 | -3,600 | -3,000 | -1,850 | -1,000 | -250 | 0 | -14,900 |
| Change due to Condition 5 | -100 | -150 | -400 | -850 | -1,500 | -2,900 | -4,200 | -3,900 | -2,500 | -1,300 | -450 | -150 | -18,400 |
| Change due to Condition 6 | -100 | -150 | -400 | -850 | -1,500 | -2,900 | -4,300 | -3,800 | -2,500 | -1,300 | -450 | -150 | -18,400 |
| Sub-basin C | | | | | | | | | | | | | |
| Average Annual Use | 250 | 450 | 1,250 | 2,350 | 4,250 | 6,900 | 9,950 | 9,250 | 6,050 | 3,300 | 1,100 | 400 | 45,500 |
| Change due to Condition 1 | 0 | 0 | 0 | 0 | -50 | -100 | -200 | -300 | -300 | -200 | -50 | 0 | -1,200 |
| Change due to Condition 2 | 0 | 0 | 0 | 0 | +100 | +200 | -100 | -300 | -350 | -200 | -50 | 0 | -700 |
| Change due to Condition 3 | 0 | 0 | -200 | -550 | -1,050 | -1,700 | -2,350 | -2,050 | -1,350 | -700 | -200 | -50 | -10,200 |
| Change due to Condition 4 | 0 | 0 | -150 | -450 | -850 | -1,350 | -1,900 | -1,650 | -1,100 | -550 | -150 | -50 | -8,200 |
| Change due to Condition 5 | 0 | 0 | -150 | -350 | -550 | -1,000 | -1,600 | -1,600 | -1,150 | -600 | -150 | -50 | -7,200 |
| Change due to Condition 6 | 0 | 0 | -150 | -350 | -650 | -1,100 | -1,700 | -1,500 | -1,050 | -550 | -150 | 0 | -7,200 |
| Sub-basin D | | | | | | | | | | | | | |
| Average Annual Use | 150 | 300 | 800 | 1,450 | 2,600 | 4,250 | 6,100 | 5,650 | 3,700 | 2,000 | 650 | 250 | 27,900 |
| Change due to Condition 1 | 0 | 0 | 0 | 0 | -50 | -100 | -250 | -250 | -200 | -150 | 0 | 0 | -1,000 |
| Change due to Condition 2 | 0 | 0 | 0 | +50 | +100 | +50 | -50 | -150 | -150 | -150 | 0 | 0 | -300 |
| Change due to Condition 3 | 0 | 0 | -50 | -50 | -250 | -500 | -700 | -650 | -400 | -250 | -50 | 0 | -2,900 |
| Change due to Condition 4 | -50 | -50 | -50 | -150 | -400 | -750 | -1,050 | -950 | -600 | -350 | -100 | 0 | -4,500 |
| Change due to Condition 5 | -50 | -50 | -100 | -200 | -400 | -750 | -1,150 | -1,250 | -850 | -500 | -150 | -50 | -5,500 |
| Change due to Condition 6 | -50 | -50 | -100 | -200 | -450 | -750 | -1,150 | -1,200 | -850 | -500 | -150 | -50 | -5,500 |

TABLE 40.--Change in outflow from sub-basins

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. | Ac. ft. |
| Sub-basin A | | | | | | | | | | | | | |
| Average Annual Outflow | 150 | 100 | 1,550 | 3,100 | 3,350 | 1,850 | 5,050 | 3,050 | 2,250 | 700 | 50 | 100 | 21,300 |
| Change due to Condition 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1,100 | -1,550 | -1,500 | -350 | 0 | 0 | -4,500 |
| Change due to Condition 2 | 0 | 0 | 0 | 0 | 0 | 0 | -1,100 | -1,050 | -1,750 | -600 | 0 | 0 | -4,500 |
| Change due to Condition 3 | | | | | No results computed for this Condition | | | | | | | | |
| Change due to Condition 4 | 0 | 0 | 0 | 0 | 0 | +650 | +1,200 | +750 | 0 | 0 | 0 | 0 | +2,600 |
| Change due to Condition 5 | -150 | -100 | -1,550 | -1,050 | -1,050 | 0 | -1,250 | -1,050 | -1,250 | -700 | -50 | -100 | -8,300 |
| Change due to Condition 6 | -150 | -100 | -1,550 | -1,050 | -1,050 | 0 | -1,250 | -1,000 | -1,000 | -700 | -50 | -100 | -8,00C |
| Sub-basin C | | | | | | | | | | | | | |
| Average Annual Outflow | 18,800 | 17,400 | 17,000 | 7,900 | 6,800 | 19,900 | 10,000 | 9,300 | 11,200 | 12,200 | 14,500 | 18,200 | 163,200 |
| Change due to Condition 1 | -600 | -400 | -400 | -300 | -100 | -100 | -1,200 | -2,100 | -2,200 | -1,000 | -600 | -700 | -9,700 |
| Change due to Condition 2 | -700 | -200 | +100 | +400 | +600 | +400 | -1,200 | -1,700 | -2,700 | -1,600 | -1,100 | -1,000 | -8,700 |
| Change due to Condition 3 | +200 | +900 | +2,100 | +8,600 | +9,100 | -3,500 | -4,300 | -4,800 | -4,600 | -3,200 | +700 | +600 | +1,800 |
| Change due to Condition 4 | -600 | +600 | +1,500 | +10,200 | +9,500 | -2,700 | -2,100 | -2,500 | -2,900 | -2,800 | +300 | -700 | +7,800 |
| Change due to Condition 5 | -3,000 | -2,700 | -4,100 | -3,400 | -3,600 | -2,700 | -4,400 | -4,700 | -5,000 | -4,200 | -3,300 | -3,100 | -44,200 |
| Change due to Condition 6 | -3,000 | -2,700 | -4,300 | -3,600 | -3,800 | -2,900 | -4,400 | -4,500 | -4,500 | -4,100 | -3,300 | -3,100 | -44,200 |
| Sub-basin D | | | | | | | | | | | | | |
| Average Annual Outflow | 9,700 | 9,200 | 8,600 | 9,700 | 12,500 | 17,800 | 14,100 | 11,900 | 12,000 | 8,400 | 7,000 | 9,100 | 130,000 |
| Change due to Condition 1 | -400 | -200 | -200 | -200 | -200 | -200 | -200 | -300 | -200 | -400 | -500 | -500 | -3,500 |
| Change due to Condition 2 | -400 | -200 | 0 | +100 | +200 | +200 | -100 | -200 | -200 | -400 | -500 | -500 | -2,000 |
| Change due to Condition 3 | -600 | -500 | -500 | +2,100 | +2,500 | -700 | -800 | -700 | -700 | -800 | -700 | -600 | -2,000 |
| Change due to Condition 4 | -1,100 | -1,000 | +100 | +4,100 | +6,000 | -1,200 | -1,200 | -1,200 | -1,100 | -1,200 | -1,100 | -1,100 | 0 |
| Change due to Condition 5 | -1,400 | -1,400 | -1,200 | -1,200 | -1,100 | -1,200 | -1,400 | -1,600 | -1,700 | -1,700 | -1,600 | -1,500 | -17,000 |
| Change due to Condition 6 | -1,400 | -1,400 | -1,200 | -1,200 | -1,200 | -1,200 | -1,400 | -1,500 | -1,700 | -1,700 | -1,600 | -1,500 | -17,000 |

## DISCUSSION OF RESULTS

The results presented in Tables 38, 39 and 40 are based on the situation which would have existed had the particular condition being investigated been in effect during the entire period. Each time the model was changed to represent a new set of conditions, the hydrologic factors, such as groundwater storage and soil moisture storage, were allowed to reach equilibrium before any results were plotted. According to the analog model, it would take 5 to 7 consecutive average years after a change in conditions was initiated to reach this equilibrium situation. The length of time to reach equilibrium in the prototype would be difficult to determine since nature is in a constant state of variation and the effects of natural variations may hide the effects of man made changes.

By examining Table 41, it is apparent the change in groundwater storage, due to the various conditions programmed, is not constant throughout the year. This occurs because the timing of flow into the groundwater reservoir is changed under the various conditions programmed. Since the amount of change in groundwater storage is not constant during the year, it is difficult to determine the average change for the year. However, the amount of change during the high consumptive use period is more significant than during the rest of the year, and the amount of change on July 1 is a good indicator of this period.

Because of the way in which this model was studied; that is, by allowing it to reach a state of equilibrium before plotting the results, there was no change in groundwater storage from the beginning to the end of the year. Figure 23 illustrates the results shown in Table 38. The efficiency at which no deficits will occur with an average water supply can be found from these curves by observing the efficiency at which each curve crosses the zero deficit line. For a smaller supply, higher efficiencies would have to be attained to overcome the deficits on the same amount of cropland.

The curves of Figure 23 can also be used to determine the amount of root-zone surplus at any specified efficiency. This surplus figure can be used to determine either the approximate amount by which the diversions could be reduced, or the increase in cropland acreage which could be irrigated. Table 42 illustrates this.

TABLE 41.--Change in groundwater storage

| Condition programmed | Change measured July 1[a] | | | Change measured December 31[a] | | |
|---|---|---|---|---|---|---|
| | Sub-basin A | Sub-basin C | Sub-basin D | Sub-basin A | Sub-basin C | Sub-basin D |
| Condition | Acre-feet | Acre-feet | Acre-feet | Acre-feet | Acre-feet | Acre-feet |
| 1 | -23,000 | -1,500 | -5,000 | -22,500 | -7,000 | -5,000 |
| 2 | -20,000 | 0 | 0 | -24,500 | -9,500 | -7,500 |
| 3 | 0 | -44,500 | -16,000 | 0 | -35,500 | -13,000 |
| 4 | -42,500 | -37,500 | -25,000 | -32,500 | -29,500 | -19,500 |
| 5 | -48,000 | -29,500 | -27,000 | -43,000 | -28,500 | -27,500 |
| 6 | -49,500 | -32,000 | -27,000 | -41,500 | -29,500 | -27,500 |

[a]Changes were measured from the average annual conditions.

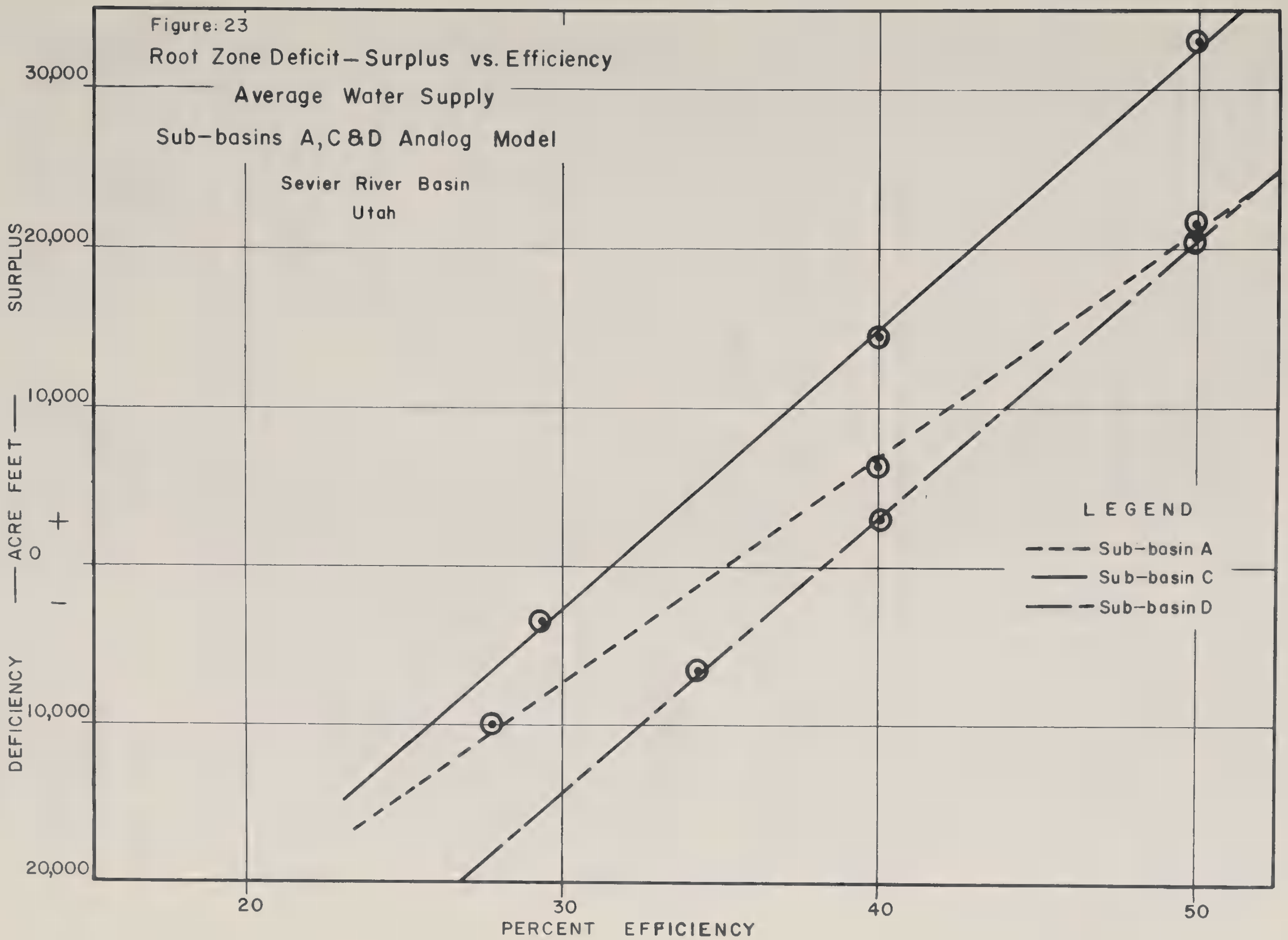



Figure: 23
Root Zone Deficit — Surplus vs. Efficiency
Average Water Supply
Sub-basins A, C & D Analog Model
Sevier River Basin
Utah

TABLE 42.--Diversion reduction or acreage increase

| Sub-basin | Potential consumptive use | Root-zone surplus | Diversion reduction | Increased acreage |
|---|---|---|---|---|
| | Inches | Acre-feet | Acre-feet | Acres |
| A | 27.88 | 14,000 | 31,100 | 6,000 |
| C | 29.82 | 23,800 | 52,900 | 9,600 |
| D | 29.82 | 12,000 | 26,700 | 4,800 |

Note: Figures in table based on 45 percent irrigation efficiency.

Unless storage is available, these surpluses could not supply the increased acreages, because the surplus occurs only during the high runoff period and in some cases, during the winter months. There is another complicating factor in this analysis. When these surpluses are used elsewhere and not allowed to enter the groundwater reservoir, the water table is lowered and the cropland direct use from groundwater is reduced causing an increased demand on the surface water supplies to meet potential consumptive use. The analog model used in this study did not compensate for this reduction in cropland use direct from groundwater. To determine this, a further refinement of the analog model program is needed. If through further field investigations the reduction in cropland use from groundwater can be estimated, that amount should be subtracted from the surplus figures in Table 42 before computing diversion reduction or acreage increase.

Changes from the average wetland consumptive use and sub-basin outflow as computed by the model for the various conditions described previously are shown in Tables 39 and 40. The outflow from Sub-basin A, which is the outflow from Gunnison Reservoir, was determined assuming no net change in reservoir storage from the first of the year to the end of the year. Where there was considerable change during the year due to the different projects, the outflow was adjusted to reflect no net change.

The effect of increasing irrigation efficiency to overcome the deficits (Table 38) was divided between the wetland consumptive use and the outflow from each sub-basin. When the present irrigation efficiencies were increased to 40 percent, the time distribution as well as the quantity of outflow was changed. However, when the efficiency was increased beyond that necessary to overcome the deficits, there was no significant change in the annual quantities of outflow or consumptive use. There was a change in the time distribution of outflow from Sub-basins C and D, but the timing change

in Sub-basin A outflow was absorbed in Gunnison Reservoir. This timing change generally increased the percentage of the sub-basin outflow which comes in the winter and spring months and decreased the late season irrigation supplies downstream.

The effects of conditions 3 and 4 on the outflow and wetland consumptive use illustrates the possibility of overcoming the consumptive use deficits on the cropland acreage with no decrease in annual outflow. By increasing the irrigation efficiency and diverting only enough to supply the consumptive needs of the cropland and maintain an annual balance of soil moisture, the outflow could be maintained at the present annual level, and in some cases increased. The reduction of irrigation water losses would cause a lowering of the water table and the resulting decrease in wetland consumptive use would offset the increased cropland use and increase in outflow, if any. Under these conditions, the outflow is increased during periods of excess supply but is reduced the balance of the year through less return flows. This increase in seasonal fluctuation of river flow indicates a need for storage, either surface or groundwater, to make this type of project effective.

For the pumping projects investigated in this model, the reductions in outflow were quite uniform throughout the year in Sub-basins C and D and would have been in Sub-basin A except for the effect of Gunnison Reservoir. The decrease in groundwater and resulting reduced outflow came from the increase in irrigation efficiency and increased pumping activity. Increased pumping of irrigation water supplemented the present canal diversions so that additional cropland acreage could be irrigated without incurring deficits. As far as the effects on the wetland consumptive use and sub-basin outflow was concerned, it didn't seem to matter whether condition 5 or condition 6 was the project instituted. The only difference being the method of increasing the root-zone water supply. The more feasible method would have to be determined through an economic analysis.

From this study, it appears that the most effective type of coordinated project would be a combination of increasing irrigation efficiency, increasing irrigation water pumped, and reducing excess diversions, if any. If the groundwater reservoir were utilized more effectively by pumping when additional water was needed and recharging during periods of excess, the seasonal and yearly fluctuations of water supply could be nearly eliminated. However, such a program would greatly reduce the wetland consumptive use along with the forage production. Also, it might prove necessary to pump directly into the river to meet downstream uses. However, the overall economic benefits from a stabilized cropland acreage and water supply may prove such a project extremely beneficial.